

Evaluation of Creature -101:
Can A Curriculum Based Serious Health Game Promote Healthy Eating and
Physical Activity among Middle School Students?

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ABSTRACT

EVALUATION OF CREATURE -101:

CAN A CURRICULUM BASED SERIOUS HEALTH GAME PROMOTE HEALTHY EATING AND PHYSICAL ACTIVITY AMONG MIDDLE SCHOOL STUDENTS?

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The purpose of this research is to evaluate the outcomes of playing a virtual reality serious game “Creature-101” at increasing fruits and vegetables, water, physical activity, decreasing processed snacks (e.g. chips, candy), sweetened beverages, and recreational screen time, and mediators of behavior change (behavioral capability, self-efficacy, outcome expectation-social and physical, autonomous motivation).

The Creature-101 game uses social cognitive and self-determination theories as framework and incorporates “creature care” in a virtual world “Tween”. Students learn scientific evidence that promote energy balance by playing mini-games, short educational videos, slideshows and interactive dialogues with game characters. Students also assess their own behaviors; create own “real life” food and activity goals, and report their progress.

The study used a pre-post matched pair intervention and control design with 590 students (65% Hispanics, 50% male, age 11-13yrs). In the intervention condition 359 students played Creature-101 in classroom 2 days/week for 1month (7sessions-30 minutes each). Two self-reported online surveys administered at baseline and immediately after intervention measured frequency and amounts of the targeted behaviors, and mediators of behavior change.

Analysis of covariance compared post-test means between groups. Students in the intervention group reported significant decrease in frequency of consumption of processed packaged snacks ($I=1.79\pm1.22$, $C=2.14\pm1.37$, $p\text{-value}<0.000$) and increase in behavioral capability ($I=5.06\pm3.91$, $C=4.06\pm 1.43$, $p=0.12$). Students also reported positive trends in consuming fewer sweetened beverages ($I=1.72\pm1.12$, $C=1.95\pm1.16$, $p=0.082$), smaller sizes of sweetened beverages ($I=1.46\pm0.88$, $C=1.65\pm0.93$, $p=0.098$) and processed snacks ($I=1.46\pm0.88$, $C=1.65\pm0.93$, $p=0.098$).

Creature-101 is encouraging as a means to promote diet and physical activity behaviors in children.

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Chapter-I

INTRODUCTION

Purpose of the study

The purpose of this study is to evaluate the effectiveness of a curriculum based “serious health game called Creature 101 (Creature-101)” among middle school students in New York City with an intention to promote healthy lifestyles to prevent childhood obesity.

The behavioral goals of Creature-101 are to: decrease sweetened beverages¹ and processed packaged snack² consumption, increase water and fruit and vegetable consumption, decrease recreational screen time activities,³ and increase physical activity. The educational objective is to increase middle school students’ (6-8th graders, Age 11-13yrs) understanding of the impact of food and activity choices on their health within the current complex food and activity environments. It uses Social Cognitive and Self Determination theories as its theoretical framework, and contents of an inquiry based nutrition science curriculum Choice, Control and Change (C3).

This “serious game” features a unique storyline in a virtual world named Tween where the previously healthy creatures had suffered due to the introduction of videogames and junk food to their culture. Each player learns about the benefits of exercise and healthy eating through a set of activities and lessons, which he or she then applies to nurturing an adopted creature back to

¹ Sweetened beverages include regular sodas, sweetened fruit juices, iced teas, sports drinks, and vitamin water.

² Processed packaged snacks include regular chips, muffins, cupcakes, brownies etc.

³ Recreational screen time activities include watching TV and playing video games for fun only.

health. Besides applying lessons to the health of the creature, the game also encourages players to improve their own eating and physical activity habits.

This evaluation study will assess the effectiveness of the game among its users by measuring changes in diet and physical activity behaviors, and the psychosocial variables that promote these behaviors.

Study background

Childhood obesity and risk of chronic diseases

Obesity is a serious health concern for children and adolescents. Obese children are more likely to become obese adults. (Serdula et al., 1993; Whitaker, Wright, Pepe, Seidel, & Dietz, 1997). According to the NHANES data of 2007-2008, 18% adolescents between ages 12-19 yrs were obese and 20% of children between 6-11 yrs were obese (Ogden, Carroll, Curtin, Lamb, & Flegal, 2010). There are significant racial and ethnic disparities in obesity prevalence among U.S. children and adolescents. In 2007—2008, Hispanic boys, aged 2 to 19 yrs, were significantly more likely to be obese than non-Hispanic white boys, and non-Hispanic black girls were significantly more likely to be obese than non-Hispanic white girls (Ogden et al., 2010). In New York City (NYC) where Creature-101 was implemented and evaluated, data from 2009 showed that 21% of children between K-8 were obese and an additional 18% were overweight (New York City Department of Health and Mental Hygiene, 2009).

The high rates in childhood overweight and obesity have led to serious concerns because of the strong associations between obesity and cardiovascular disease risks, hypertension, dyslipidemias and childhood onset type-II diabetes mellitus (Freedman, Khan, Dietz, Srinivasan, & Berenson, 2001; M. D. Weiss et al., 2004; Weiss & Caprio, 2005, 2006; R.

Weiss et al., 2004). Other consequences of childhood and adolescent obesity are psychosocial. Obese children and adolescents are targets of early and systematic social discrimination that can cause low self-esteem which, in turn, can hinder academic and social functioning (Swartz & Puhl, 2003).

Overweight and obesity and their associated health problems also have significant economic impacts on the U.S. health care system due to increased medical costs (U.S. Department of Health and Human Services, 2001). The total cost of obesity related morbidity and mortality was about \$147 billion in 2008 dollars (Finkelstein, Trogon, Cohen, & Dietz, 2009).

Behavioral factors associated with obesity

Obesity may be caused by several factors that include genes, metabolism, behavior, environment, culture, and socioeconomic status. However, the main cause of overweight and obesity is considered to be energy imbalance. Energy imbalance is the discrepancy between the calories one consumes as food and beverages and the calories one uses to support normal growth and development, metabolism, and physical activity.

A study by Reedy et al showed that the top sources of energy for 2- to 18-year-olds in the US are grain desserts, pizza and sodas (Reedy & Krebs-Smith, 2010). Sugar sweetened beverages, comprising of both sodas and fruit dinks, are frequently consumed by children. Excessive consumption of these drinks are also associated with obesity as these drinks are high in calories (Libuda & Kersting, 2009). At the same time consumption of water is low among children and adolescents (Kant & Graubard, 2010).

Data also suggest that snacking trends in terms of consumption of fried snacks, candies and baked goods have increased. Children now consume on an average of three snacks per day

(Piernas & Popkin, 2010). Higher consumption of fast and fried food among children has also been linked to childhood obesity (Paeratakul, Ferdinand, Champagne, Ryan, & Bray, 2003). On the other hand, consumption of fruit and vegetables that have been shown to reduce risk of obesity and other chronic diseases is low (Ledoux, Hingle, & Baranowski, 2011). Mean intake of total fruit and vegetables in NHANES 2001-2004 for adolescents was 1.2-1.5 servings per day as compared to the recommended 9 servings (or 4-1/2 cups) per day (Bradlee, Singer, Qureshi, & Moore, 2010; National Cancer Institute, 2010).

Participating in physical activity is important for children and teens as it has beneficial effects on body weight (Dietz & Gortmaker, 1985; William et al., 2005). However, the Center for Disease Control reports show that children are less engaged in physical activity and spend considerable amount of time with media. A study found that time spent watching TV, videos, DVDs, and movies averaged over 3 hours per day among children aged 8–18 yrs (Roberts, Foehr, & Rideout, 2005). Several studies have found positive associations between the time spent viewing television and increased prevalence of obesity in children (Dietz & Gortmaker, 1985; Gortmaker et al., 1996; Matheson, 2004).

Prevention of childhood obesity

Since obesity in children and adolescents is largely a result of unhealthy eating and physical activity behaviors, it is important to instill healthy behaviors from childhood to prevent obesity in childhood and in later life. Establishing healthy behaviors during childhood is easier and more effective than trying to change unhealthy behaviors during adulthood as motivation may be easier to generate while the child is young (Baranowski et al., 2000). In addition, adolescence is a time when individuals develop heightened autonomy and begin making their own decisions about eating and physical activity (Dietz, 1998). During this time social influences

such as one's peer group become increasingly important to motivations, decisions, and behaviors (Bandura, 1969; Brogan et al., 2012; Farrow, 2011; Tremblay & Lariviere, 2009).

Studies have shown that both improved eating patterns and increased physical activity are important to reduce risks of obesity (Gollwitzer; Sherry; Strong et al., 2005). However, there is lack of strong evidence as to how to assist children and youth to develop healthful behaviors to achieve and maintain healthy weight (Procter, 2007). Research is constantly in search for effective interventions.

Role of theory in designing interventions

In order to develop effective interventions to modify diet and physical activity behaviors, research has shown that use of behavior change theories is highly valuable (Hochbaum, Sorenson, & Lorig, 1992; Jackson, 1997). Behavioral theories provide information on why people behave the way they do, and to modify those behaviors. Theories help researchers to design effective intervention programs for behavior change by providing constructs that help to explain the changes in behaviors. These constructs are called mediating variables (Bandura, 2004) A literature review by Cerin et. al. has suggested that for school based interventions for youth (ages 5-18) self-efficacy, outcome expectation, and habit strength have emerged as mediators most consistently among various studies for dietary behaviors (Cerin & Mackinnon, 2009). For physical activity, self-efficacy emerged as the strongest mediator in most interventions with children and adolescents (Lubans, Foster, & Biddle, 2008).

Many theories have been used in designing obesity prevention programs in children and adolescents including Social Cognitive Theory (SCT), Self- Determination Theory (SDT), Behavior Inoculation theory (BIT) and others. Alone each theory provides insight into limited

aspects of behavior change but together they provide a more comprehensive framework within which behavior change interventions can be developed.

The two theories, namely SCT and SDT, pertinent to this research are discussed below:

Social Cognitive Theory

The social cognitive theory (SCT), proposed by Bandura (Bandura, 1969), posits that the three factors environment, personal and behavior are constantly influencing each other. Core constructs include: knowledge of the relationship between dietary health practices and health risks, perceived self-efficacy, self-regulatory skills, goal setting, and perceived environmental facilitators and impediments to making health behavior changes (Bandura, 2004). Additionally, SCT cites modeling as a method to increase behavioral capability and behavioral skills, which could then in turn enhance self-efficacy beliefs in individuals (Bandura, 1969; Thompson, Baranowski, Cullen, & Baranowski, 2007). Interventions aimed at changing youth diet and physical activity behaviors have employed these constructs with some success (Baranowski, Baranowski, et al., 2003; Baranowski et al., 2000; Evans et al., 2006; Thompson, Baranowski, Buday, et al., 2007).

Self Determination Theory

SDT posits that interpersonal contexts that facilitate satisfaction of the basic human psychological needs for competence, autonomy, and relatedness enhance autonomous motivation. Autonomous motivation consists of both intrinsic motivation and well-internalized extrinsic motivation. Intrinsic motivation involves doing a behavior because the activity itself is interesting and spontaneously satisfying. When intrinsically motivated, people perform activities because of the positive feelings resulting from the activities themselves. Extrinsic motivation, in contrast, involves engaging in an activity because it leads to some separate consequence such as

obtaining a tangible reward or avoiding a punishment. However, research shows that extrinsic motivation can still be autonomous when it becomes well internalized. SDT emphasizes that if an individual experiences support for basic psychological need satisfaction, he is more likely to internalize the behavior even if it is performed due to some tangible rewards (Deci & Ryan, 2008).

Schools as potential targets for obesity prevention

Children in US spend roughly a third of every weekday, equivalent to about 32.5 hours a week, in schools (Swanbrow, 2004) While they are there, they can consume up to two meals, sometimes even three, plus snacks (Story, Kaphingst, & French, 2006). These serve as rationales for implementation of school-based behavioral intervention programs (Brown & Summerbell, 2009).

Middle school represents a strategic time and place in which to study interventions to influence risk factors for obesity. This is a time of both physical and metabolic as well as emotional and mental growth and development. Diet and physical activity behaviors are in flux during this period, and this transition represents an optimal opportunity to encourage healthier behaviors (Healthy Study Group, 2010).

There are several popular school based obesity prevention interventions targeted to middle school students (the target population of this study) that have shown to be successful at promoting positive eating and physical activity behaviors among this age group. The major ones are briefly discussed below:

Planet Health aimed at increasing energy expenditure with promoting dietary behaviors according to dietary guidelines. The intervention focused on reducing television viewing and increasing physical activity; decreasing consumption of high-fat foods; and increasing

consumption of fruits and vegetables. The intervention decreased obesity prevalence and increased obesity remission among girls (not boys). Girls increased their fruit and vegetable intake by 0.2 servings, and TV viewing time decreased among both boys and girls. Dietary energy intake decreased over the 2 school yrs (Gortmaker et al., 1999).

The **Middle School Physical Activity and Nutrition (M-SPAN) study** evaluated the effects of environmental, policy, and social marketing interventions on physical activity and fat intake. The study aimed to increase total energy expenditure from physical activity, and decrease grams of total and saturated dietary fat purchased at, or brought to school by students. There was no change in the consumption of low fat foods, but the intervention group significantly showed increase in physical activity. Boys (not girls) in the intervention group also showed significant decrease in BMI. The study stressed on the role of school environmental and policy interventions as an important part of obesity prevention program in school (Sallis et al., 2003).

The **TEENS** study was conducted with the goal of developing and evaluating the effectiveness of classroom, school-wide, and family programs to increase fruit and vegetable intake and decrease fat intake among seventh and eighth graders to reduce their future risks of cancer. The intervention was targeted to increase student-level intake of fruits, vegetables, and energy from fat. Students showed some improvement in fruit and vegetable consumption after one year, but the results were not maintained at the end of the second year (Lytle et al., 2004).

The **Dutch Obesity Intervention in Teenagers (DOiT) Study** was conducted in middle schools in The Netherlands. It targeted adolescents' ages 11-13 yrs and aimed at preventing excessive weight gain. The intervention focused on reducing consumption of sugar-sweetened beverages, reduction of energy intake derived from snacks, decrease in levels of sedentary behavior, and increase in levels of physical activity (i.e. active transport behavior and sports

participation). The DOiT-intervention reduced sweetened beverage consumption among both boys and girls. Boys in intervention schools also improved their attitude towards decreasing sweetened beverage consumption, while this behavior became less of a habit (Chin A Paw, Singh, Brug, & van Mechelen, 2008; Singh et al., 2006).

The **Choice, Control & Change (C3) Study** was conducted to examine the impact of a curriculum intervention on the adoption of energy balance related behaviors of decreasing sweetened drinks, packaged snacks, fast food, and leisure screen time, and increasing water, fruits and vegetables, and physical activity. The intervention consists of lessons that used science inquiry investigations to enhance motivation for action. Evaluation results showed that students in intervention schools reported consumption of considerably fewer sweetened drinks and packaged snacks, smaller sizes of fast food, increased intentional walking for exercise, and decreased leisure screen time and substantial increases in positive outcome expectation about the behaviors, self-efficacy, goal intentions, competence, and autonomy (Contento, Koch, Lee, & Calabrese-Barton, 2010).

The **HEALTHY Study** was designed to respond to increasing rates of overweight, obesity, and type 2 Diabetes mellitus in youth. The program integrated multiple components in nutrition, physical education, behavior change, and social marketing-based communications. The study increased the intake of fruit by 10%, and water by 2 fluid ounces in the intervention schools as compared to controls (Siega-Riz et al., 2011). There was a decrease in the prevalence of overweight and obesity in both groups, but with no difference between the groups (Healthy Study Group, 2010).

School-based interventions to change diet and physical activity have shown some success at promoting healthy eating and physical activity behaviors but have not been able to attenuate or

prevent the obesity epidemic. This suggests that we are in need for newer approaches to help children and adolescents adopt and maintain healthful eating and physical activity behaviors to prevent the epidemic of childhood obesity. Though school settings are promising locations to promote healthy nutrition to children, but barriers such as the need to expend resources for staff trainings and frequent staff turnover hamper successful implementation (Kelder, 2005).

Innovative approaches are needed to mitigate these barriers while providing educational fidelity, seamless implementation within the school day, and minimal teacher oversight. Educational video games may contribute to a solution. During the last decade, increasing research and application of educational games has demonstrated a positive impact on children's cognitive development, dietary habits, and physical activity behavior (Beasley et al., 2012). However, few evidence-based educational games are currently available for middle school children.

Uses of digital media among children and adolescents

Children and adolescents are frequent users of media both at home and at school. Today in United States approximately 93% of teens (aged 12–17 yrs old) go online (Wilson, 2010). Only 15% of households lack a personal computer (Daley, 2009). 83% of American youth have access to at least 1 video game device in their bedroom (Biddiss & Irwin, 2010). 8-18 year-olds devote an average of 7 hours and 38 minutes to using entertainment media across a typical day (more than 53 hours a week) (Kaiser Family Foundation, 2010). In addition to computers, children are also extensive users of digital devices and video games are a big part of their digital experiences (Baranowski, Buday, Thompson, & Baranowski, 2008).

Rationale for using video games for behavior change among children and adolescents

Video games to promote behavior change capitalize on children's pre-existing attention and enjoyment of them. Given the fact that a child's attention is already captured by video gaming, research is targeted at developing games for obesity reduction (and prevention) and health promotion. Video games for behavior change embed functional behavioral capability and change procedures such as goal setting, modeling, and skill development activities into a personally meaningful, entertaining, and immersive game environment. These games are commonly referred to as "serious video games" and are specially designed to entertain players as they educate, train, or change behavior (Stokes, 2005). Research shows that "serious video games" may serve as effective behavior change channels for diet and physical activity among children and adolescents as well (Baranowski et al., 2003; Brown et al., 1997).

In recent yrs video games have evolved into very rich and complex "virtual worlds". These sophisticated simulating environments can be used for entertainment, education, and social interactions. The exponential increase in computing power coupled with integration of the Internet into mainstream society has given rise to numerous gaming environments and "virtual worlds". These worlds are complex, immersive, engaging, and enabling of a wide range of activities, goals, and social behavior. They are also referred to as "virtual reality" games. They consist of a digital environment that is a representation of either a real or imaginary geographic 'place', and requires that a user adopt a character, avatar, or personality that resides within that world and is the means by which the user interacts with the world (Rigby & Przybylski, 2009). The new generation "serious games" use these "virtual worlds" for delivering its content and are mostly played online. They have shown to be effective in educating, motivating and promoting

behavior change among its players (Beard, 2009; Johnston, 2012; Kato, Cole, Bradlyn, & Pollock, 2008).

Literature suggests that video games are being used in the fields of education, health promotion and nutrition education. The following section will provide an overview of the games that have been developed, implemented and evaluated in these areas for middle-school children.*

Video games for education

Research has shown that teaching through electronic media can be more enjoyable, more interesting, and more effective over classroom teaching as they are more compelling and engaging in nature, and they can support multi-sensory, active, experiential, problem-based learning, and they provide immediate feedback enabling players to test hypotheses and learn from their actions (Papastergiou, 2009). Two educational games that are currently being tested on a large scale are **Quest Atlantis** and **River City**.

Quest Atlantis is a multiuser virtual environment created to immerse children (ages 9 to 12) in educational tasks. Students conduct environmental studies, research other cultures, interview community members, and develop action plans to complete their educational activities (Quests). (Barab, Thomas, Dodge, Carteaux, & Tuzun, 2005). Students assigned to the game-based unit reported significantly higher levels of engagement, had different goals motivating their participation, and received fewer teacher reprimands to stay on task when compared to students who completed the same set of activities in a story-based classroom unit (Barab, Pettyjohn, Gresalfi, Volk, & Solomou, 2012).

* For the purposes of this review only games that have been evaluated were considered.

River City developed by Harvard School of Education, is a curriculum based educational game. Learning is conducted within a technology-based curriculum, called River City. The game engages students in a collaborative scientific inquiry-based learning experience. Students conduct their scientific investigations in a virtual historical town populated by themselves, digitized historical artifacts, and computer agents in order to detect and decipher a pattern of illness that is sweeping through the virtual community (Ketelhut, 2010). Students showed increase in self-efficacy and learning processes (Ketelhut, 2007)

Video games for health promotion

A review of literature demonstrates that video games can positively affect health behaviors and outcomes (Kato, 2010). Games and simulations have potential to help adolescents personalize information, forcing them to assess risks and consequences and make decisions in a hypothetical yet realistic situation. They can broadly be divided into two categories namely games for disease risk prevention, and games for self-management.

An example of a disease risk prevention video game is **Health Works** developed by the AIDS education program of the New York State Department of Health for school children in grades 5-8. It was an interactive computer video program used by more than 17,000 students at 172 schools in New York State, including NYC. A study with NYC children in grades 5-8 found that the video game enhanced students' cognitive learning about AIDS (Thomas, Cahill, & Santilli, 1997).

Two teenager pregnancy prevention games (**The Baby Game and Romance**) were targeted at adolescents who are sexually active and inclined to become parents during their adolescence. These games were aimed at improving adolescents' behavioral capability of adolescent parenthood and sexual behaviors, and cause their attitude changes favoring delayed

pregnancy and use of effective contraception (Paperny & Starn, 1989). The smoking prevention game **Rex Ronan** was designed to strengthen preadolescents' negative attitude toward smoking cigarettes (Lieberman, 2001). Evaluation studies showed that the game was very attractive to children, and playing increased their behavioral capability of specific negative effects of smoking on the body and their interest in learning more (Lieberman, 2001).

Video games have also been applied to improve self-management skills for coping with certain chronic diseases, such as asthma, diabetes, cancer, and so forth.

“**Packy & Marlon**”, an interactive video game was designed to improve self-care among children and adolescents with type-1 diabetes. Children learnt to manage their diabetes by monitoring blood glucose, taking proper amounts of insulin, reviewing a diabetes logbook, and finding appropriate food. Results of a randomized study found that participants significantly improved their communication with parents about diabetes and self-care behaviors. Those who used the interactive video game for six months their diabetes related emergency room visits reduced by 77 percent (Brown et al., 1997; Lieberman, 1995).

Re-Mission is a computer game that included 20 missions/levels designed for young cancer patients. The intervention significantly improved treatment adherence and indicators of cancer-related self-efficacy and behavioral capability in those who were undergoing cancer therapy (Kato et al., 2008).

Games are being increasingly used for therapy and rehabilitation. Evaluation studies on the effectiveness of electronic games used for health-related purposes suggest that almost all the games demonstrated a strong effect in teaching related behavioral capability (Skiba, 2008).

Use of video games in the promotion of nutrition and physical activity^{*}

Two popular games that have been used successfully evaluated and showed promise at promoting eating and physical activity behaviors are “Squire’s Quest” and “Escape from Diab and Nanoswarm Escape from inner space”.

Squire’s Quest was a 10-session computer game designed to increase children’s consumption of fruit, juice, and vegetable (FJV), to prevent cancer and other illnesses in the long run. It’s storyline was an action adventure where the players “role played” the characters of the game. It used constructs of the Social Cognitive Theory to promote goal setting, problem solving and decision making among its players. It targeted 4th graders and results of the intervention found that the intervention group increased their FJV consumption by 1.0 serving more than those in the control group. This was one of the largest improvements reported in literature so far for fruit and vegetables intake in this age group. Hence, the study demonstrated that the electronic game approach was an effective way to promote healthful diets among children. (Baranowski, Baranowski, et al., 2003).

“Escape from Diab” and “Nanoswarm: Escape from inner space” were developed by the Children’s Nutrition Center at the Baylor College of Medicine and Archimage. “Escape from Diab” focused on behavioral objectives of getting the players set goals to eat 3-5 servings of vegetables per day, drink more water, and exercise at least 60 minutes per day. The game’s storyline used a virtual world where the players found themselves in a world where they are encouraged to eat junk all through the day and discouraged to eat any kind of healthy food. The players “role played” a character named “DeeJay” to alter the behaviors of other characters in the

^{*} Exergames (games that promote active exercises like Wii, Dance Dance Revolution etc) are beyond the scope of this review.

game. “Nanoswarm: Escape from inner space” used a similar storyline but different game characters. “Diab” targeted adolescent youth while “Nanoswarm” targeted middle school students (Thompson, Baranowski, Cullen, et al., 2007). Outcome evaluations of both games showed that participants increased their intake of fruit and vegetables intakes by 0.67 serving per day, with no change in their water intakes or physical activity. There were no changes in the players’ proposed psychosocial mediators of behavior change (Baranowski et al., 2011).

Another game **“Fritter Critters”** that won the second prize in the U.S. Department of Agriculture (USDA)/Michelle Obama 2010 Apps for Healthy Kids contest, is a videogame intended for used in schools for children 8–12 yrs old for improving healthy diet and activity. The game had 17 quests to enhance motivation for game playing, help master the game basics, and increase nutrition and activity behavioral capability based on the USDA recommendations. Based on a one-week implementation, the evaluation results showed changes in positive attitudes and self-efficacy towards eating healthy (Schneider et al., 2012).

The games reviewed above encouraged healthy behaviors by addressing personal factors associated with behavior change. They either focused primarily on promoting consumption of fruit and vegetables and increase in physical activity or dietary guidelines. They do not address the whole range of eating behaviors that lead to energy imbalance; and hence obesity in this age group. This study converted an existing evaluated curriculum Choice, Control, and Change (C3) into a serious game Creature-101 and tested its effectiveness.

“Choice, Control & Change” (C3) Curriculum as the content for Creature-101

The content of Creature-101 is based on an evaluated curriculum “Choice, Control & Change (C3) curriculum which is an inquiry based science curriculum developed by The Program in Nutrition at Teachers College, Columbia University and is targeted at reducing risk

of obesity by promoting healthy eating and physical activity behaviors. It sought to enhance motivation, increased knowledge in nutrition and provided skills to achieve and maintain a healthy body within the complex real life environments. It specifically targeted the following behaviors: reducing intake of sweetened beverages and increasing water intake, reducing eating out in fast food restaurants, increasing fruit and vegetable intake, reducing intake of packaged snacks and increasing physical activity. It was successfully evaluated with positive behavioral and psychosocial outcomes (Contento et al., 2010; Contento, Koch, Lee, Sauberli, & Calabrese-Barton, 2007).

Rationale for the study

In the area of nutrition education, serious games such as “Squires Quest” and “Diab and Nano” focused primarily on increasing fruit and vegetables and physical activity among middle school children. They do not address other eating behaviors such as consumption of sweetened beverages and processed snacks that are high among this age group as suggested by national data. Decrease in intakes of these could effectively reduce consumption of additional calorie intake, thus improving energy balance in this population. Creature-101 emphasized the complex interactions of biology, personal behavior, and the environment that influence eating and physical activity. It targeted a range of eating and physical activity behaviors in a single intervention that others did not target before.

Research Questions

This study evaluated the impact of Creature-101 on middle school students eating and physical activity behaviors by addressing the following questions:

- 1) What was the impact of the game on eating behaviors in the intervention group as compared to a control group?
 - a) Did the students in the intervention group report consuming fewer
 - i) sweetened beverages?
 - ii) processed packaged snacks?
 - b) Did the students in the intervention group report consuming more
 - i) water?
 - ii) fruits and vegetables?
- 2) What was the impact of the game on physical activity behaviors in the intervention group as compared to a control group?
 - a) Did the students in the intervention group report decreased recreational screen time?
 - b) Did the students in the intervention group report increased physical activity?
- 3) What was the impact of the game on the mediating variables in the intervention group as compared to the control group?

Did the students in the intervention group report increase or changes in

 - a) Behavioral capability?
 - b) Outcome expectation (social and physical)?
 - c) Self-efficacy?
 - d) Autonomous motivation?

Significance of the Study

The study aimed to understand the contribution of Creature-101 as an educational, engaging and interactive serious game to promote healthy eating and physical activity behaviors

among middle school students. It evaluated the effectiveness of this inquiry based science and nutrition curriculum delivered as a virtual reality game with the goal of instilling knowledge, motivational skills and competence about nutrition and physical activity to enable students to make healthy diet and exercise choices in a complex environment. If found to be effective it can be used in schools and after school programs, and will thus help to improve overall health in children and adolescents and reduce their risks of chronic diseases in future.

CHAPTER II

LITERATURE REVIEW

The pandemic of childhood overweight and obesity

Overweight and obesity are considered serious health concerns for children and adolescents. The definitions of overweight and obesity for children and adolescents (aged 2–19 yrs) are based on 2000 CDC Growth Charts for the United States. Overweight is defined as BMI at or above 85th percentile and lower than 95th percentile, and obesity is defined as BMI at or above 95th percentile for children of the same age and sex (Barlow, 2007).

Recent data from NHANNES surveys between 1976 to 1980, and 2003 to 2006, show that prevalence of obesity among children in the US, between 2-5 yrs old has increased from 5.0 to 12.4%, in 6-11 yrs old from 6.5 to 17.0%, and among 12-19 yrs old from 5.0 to 17.6%. Results from the 2007-2008 NHANES surveys indicate that an estimated 16.9% of children and adolescents aged 2-19 yrs are obese (Ogden, Carroll, & Flegal, 2008; Ostchega et al., 2009). The rates of overweight and obesity among children and adolescents are also high in New York City where this research study was conducted. 2009 data from the New York City Department of Health and Mental Hygiene, showed that 21% of children between K-8 were obese and an additional 18% were overweight (New York City Department of Health and Mental Hygiene, 2009).

Overweight and obesity are serious concerns because obese children are more likely to become obese adults (Serdula et al., 1993; Whitaker et al., 1997). Strong associations have been found between overweight and cardiovascular disease risks, hypertension, dyslipidemias and

type-II diabetes mellitus beginning in childhood (Freedman et al., 2001; Ostchega et al., 2009; Weiss & Caprio, 2005, 2006; R. Weiss et al., 2004; Weiss, Taksali, & Caprio, 2006). Overweight and obese children and adolescents are more prone to other morbid conditions such as asthma, hepatic steatosis (fatty degeneration of the liver) and sleep apnea (sleep associated breathing disorder) (Dietz, 1998). Childhood and adolescent obesity also causes earlier puberty and menarche in girls (Biro & Wien, 2010). Other consequences of childhood and adolescent obesity are psychosocial. Obese children and adolescents are targets of early and systematic social discrimination. The psychological stress of social stigmatization can cause low self-esteem which, in turn, can hinder academic and social functioning, and persist into adulthood (Swartz & Puhl, 2003).

Overweight and obesity and their associated health problems have significant economic impacts on the U.S. health care system (U.S. Department of Health and Human Services, 2001). Medical costs associated with overweight and obesity involve both direct and indirect costs (Wolf & Colditz, 1998). Direct medical costs include preventive, diagnostic, and treatment services related to obesity. Indirect costs relate to morbidity and mortality costs. Morbidity costs are defined as the value of income lost from decreased productivity, restricted activity, absenteeism, and bed days. Mortality costs are the value of future income lost by premature death. In 2008 dollars, these costs totaled to about \$147 billion (Finkelstein et al., 2009).

Minority groups share a disproportionate risk of obesity and obesity-related diseases. Hispanics and Blacks have significantly higher odds of obesity and its related diseases (Dubowitz et al., 2008; Zhang, 2012).

Risk factors of childhood overweight and obesity

Varieties of factors play a role in overweight and obesity that makes it a very complex issue. Excess body weight may be the result of genes, metabolism, behavior, environment, culture, and socioeconomic status. Many dietary and physical activity related risk factors are associated with overweight and obesity are discussed below.

Dietary risk factors related to childhood overweight and obesity

Research has established that childhood obesity is a result of an imbalance between the calories a child consumes as food and beverages and the calories a child uses to support normal growth and development, metabolism, and physical activities. It has also been realized that children now consume many more calories than they use. A study by Reedy et al found that the top sources of calorie for 2- to 18-year-olds in the US are grain desserts (138 kcal/day), pizza (136 kcal/day), and soda (118 kcal/day). Intakes of sugar-sweetened beverages have become very high, providing approximately 173 kcal/day (Reedy & Krebs-Smith, 2010). Among 2-18 year old children and adolescents in the US, the average daily intake of energy from added sugars is 365 kcal (National Cancer Institute, 2010). The major sources of added sugars are soda (116 kcal/day from added sugars), fruit drinks (55 kcal), grain desserts (40 kcal), dairy desserts (29 kcal), and candy (25 kcal).

The Dietary Guidelines Advisory Committee (DGAC) conducted a full Nutrition Evidence Library (NEL) search to evaluate the association between sugar-sweetened beverages and adiposity in children. They concluded that strong evidence supported the conclusion that greater intake of sugar-sweetened beverages is associated with increased adiposity in children.

Overall, the majority of included studies (12 of 19) found a positive association between sugar-sweetened beverage intake and adiposity in all or a subsample of the population studied.

Sugar-sweetened beverages (soda, energy and sports drinks and fruit drinks) are the top two sources of calories from added sugars among nearly all age and demographic groups.

Adolescents, 14-18 yrs of age, consume on average 260 kcal/day of added sugars from sugar-sweetened beverages; 9-13 year olds consume 168 kcal/day; 4-8 year olds consume 121 kcal/day; and for 2-3 year olds, 60 kcal/day. Among all racial/ethnic and income groups, sugar-sweetened beverages contributed almost half (45-50%) of the daily energy intake from added sugars. For non-Hispanic Blacks, more added sugars are consumed from fruit drinks than soda (United States Department of Agriculture, 2010). The DGAC also concluded that reducing sweetened beverage consumption among children could actually decrease adiposity. In a study by Ebbeling et al (2006), children in the upper third of the BMI distribution at baseline reduced adiposity subsequent to reducing intake of sweetened beverages (Ebbeling, 2006), and a randomized control trial conducted by James et al (2004) found that a targeted, school-based education program that produced a modest reduction in the number of carbonated drinks consumed, was associated with a reduction in the number of overweight and obese children (James, 2004).

At the same time consumption of water is low among children and adolescents. Dietary data for children 2–19 yrs of age from the National Health and Nutrition Examination Survey 2005–2006 showed that the mean intakes of total water⁴ in American children aged 2–5, 6–11, and 12–19 yrs were 1.4, 1.6, and 2.4 L, respectively. These are considered inadequate (Kant & Graubard, 2010). A recent study by Kant and Graubard examined data from the NHANES 2005-

⁴ The NCHS defines “total water” as the amount of “plain water” plus the moisture from food and beverages. Plain water includes drinking water from tap, water fountains, spring water, and bottled water.

2006 survey and reported that plain water intake was an inverse predictor of sweetened beverage consumption. The quality of food selection was more favorable with plain water intake. In respondents 6–19 y of age, plain water intake was related to higher fiber intake, and, not surprisingly, with higher food moisture and lower energy density of foods. The authors recommended that American children and adolescents are more likely to consume beverages with their main meals. Therefore, efforts to moderate the consumption of sweetened beverages and promote plain water intake should not only continue to promote plain water for snacks but also should recognize the importance of replacing nonnutritive beverages at meal time with plain water (Kant & Graubard, 2010). A study conducted by Wang et al. confirm these national data and suggest that increase in water intake can reduce the total energy intake in children and adolescents by an average of 235 calories per day that could prevent weight gain (Wang, Ludwig, Sonnevile, & Gortmaker, 2009). The Center for Disease Prevention also recommends that adolescents should drink fewer sugar-sweetened beverages and more water (Center for Disease Control and Prevention, 2011). A study by Hu et al. also concluded that consumption of sugar sweetened beverages should be replaced by water to reduce risk of obesity and chronic diseases (Hu & Malik, 2010).

Data on snacking trends in terms of consumption of fried snacks, candies and baked goods showed that the consumption of these items has increased. Research shows that snacking is an energy balance-related behavior associated with excess energy intake and obesity in children and adolescents (Sturm, 2005; Templeton, 2005). The prevalence of snacking in children and adolescents has increased over the last decades. Children in the United States now consume almost three snacks per day that accounted for up to 27% of children's daily caloric intake (Piernas & Popkin, 2010). Evidence is also strong for a relationship between higher

consumption of fast and fried food among children and childhood obesity (Eagle et al., 2012; Paeratakul et al., 2003).

On the other hand, consumption of fruits and vegetables that have been shown to reduce risk of obesity and other chronic diseases is less among this age group (Ledoux et al., 2011). Analysis of NHANES data from 2002-2004 found that nearly the entire U.S. population, both children and adults, consumed a diet that was low in fruit and vegetables (Krebs-Smith, Guenther, Subar, Kirkpatrick, & Dodd, 2010). The mean intake of total vegetables in NHANES 2001-2004 for adolescents was 1.2-1.5 servings per day as compared to the recommended 9 servings per day (Bradlee et al., 2010; National Cancer Institute, 2010). As students moved from elementary to middle schools, their consumption of fruits and vegetables decreased. Fruit consumption fell by 41% between the third and the eighth grades while vegetable consumption fell by 25% (Lytle L.A, Seifert S, Greenstein J, & P., 2000). In addition, among adolescents, longitudinal trends indicated that adolescents decreased their daily intake of fruit and vegetables by an average of 0.7 servings during the transition from early to middle adolescence, and by 0.6 servings from middle to late adolescence (Lorson, Melgar-Quinonez, & Taylor, 2009). A cross-sectional study by Holt et al. showed that on the other hand consumption of fruit and vegetables among adolescents had beneficial effects on the markers of inflammation and oxidative stress that are already present by early adolescence and that later in life can cause increased risks of stroke and cardiovascular diseases (Holt et al., 2009). A review by Ledoux et al. suggested that in longitudinal studies, high fruit and vegetables consumption was associated with less or slower weight gain over lengthy time intervals among adults and to some degree among children (Ledoux et al., 2011). Racial and ethnic disparities have been observed in fruit and vegetable

consumption, Black and Hispanics consume fewer fruit and vegetables than the whites (Engels, Gretebeck, Gretebeck, & Jiménez, 2005; Kant, Graubard, & Kumanyika, 2007; Lucan, 2010).

Hence, review of literature suggests that increased consumption of sweetened beverages, snacks and fried food, and decreased consumption of fruit and vegetables and water are associated with increased risk of overweight and obesity among children and adolescents.

Inadequate physical activity as a risk factor for childhood overweight and obesity

Participating in physical activity is important for children and teens as it has beneficial effects not only on body weight, but also on blood pressure and bone strength (Dietz & Gortmaker, 1985; William et al., 2005). Physically active children are also more likely to remain physically active throughout adolescence and possibly into adulthood. The CDC and the American Academy for Pediatrics (AAP) recommend that children and teens should participate in at least 60 minutes of physical activity on most days of the week, preferably daily, and must include aerobic, muscle strengthening and bone strengthening activities. Aerobic activity should make up most of the child's 60 or more minutes of physical activity each day and can include either moderate-intensity aerobic activity such as brisk walking, or vigorous-intensity activity such as running. Vigorous-intensity aerobic activity should be done on at least 3 days per week. Muscle strengthening activities such as gymnastics or push-ups should be done at least 3 days per week as part of the child's 60 or more minutes and bone-strengthening activities such as jumping rope or running should be done at least 3 days per week as part of the 60 or more minutes. In addition to doing physical activity, children should avoid being too much sedentary. Children should limit their recreational screen time such as watching television, playing video games for recreation, or surfing the web for non-educational purposes to no more than 2 hours per day (Center for Disease Control and Prevention, 2005). However, CDC reports showed that

children are less engaged in physical activity and spend considerable amount of time with media. One study found that time spent watching TV, videos, DVDs, and movies averaged slightly over 3 hours per day among children aged 8–18 yrs (Roberts et al., 2005). Several studies have found positive associations between time spent viewing television and increased prevalence of obesity among children (Dietz & Gortmaker, 1985; Gortmaker et al., 1996; Matheson, 2004). Media use, and specifically television viewing, may displace time children spend in physical activity (Lori & Leann, 2006), contribute to increased energy consumption through excessive snacking and eating meals in front of the TV, influence children to make unhealthy food choices through exposure to food advertisements (Magnus, 2009; Medicine., 2005), and lower children's metabolic rate (Treuth, Butte, & Wong, 2000). Being physically active (e.g. sport activity ≥ 2 days per week) has been shown to protect against overweight in young children while low physical activity levels (such as spending ≥ 3 hours per day watching TV) increased the risk for obesity (Aranceta et al., 2007; Hussain, Claussen, Ramachandran, & Williams, 2007; Kirk, Scott, & Daniels, 2005). Physical activity interventions have shown to be successful in reducing both visceral fat and total adiposity among obese adolescents (Hussain et al., 2007).

Obesity prevention among children and adolescents

Since obesity in children and adolescents occur largely as a result of unhealthy eating and physical activity behaviors it is important to instill these behaviors from childhood to prevent obesity in later life. Establishing healthy behaviors during childhood is easier and more effective than trying to change unhealthy behaviors during adulthood (Baranowski et al., 2000).

Prevention efforts should begin at younger ages due to the following reasons: (1) motivation may be easier to generate and maintain while the child is young; (2) it can be easier to control and modify behaviors in younger individuals since there may be less resistance to treatment

stigmatization; and (3) there may be more frequent opportunities for medical observations during earlier childhood compared with later yrs (Lobstein, 2004). In addition, adolescence is a time when individuals develop heightened autonomy and begin to make their own decisions about eating and physical activities, making it a crucial life phase for the study of obesity (Dietz, 1998). Social influences such as one's peer group become increasingly important to motivations, decisions, and behaviors during this time (Bandura, 1969; Brogan et al., 2012; Farrow, 2011; Salvy, de la Haye, Bowker, & Hermans, 2012; Tremblay & Lariviere, 2009).

Studies have showed that both improved eating patterns and increase in physical activities are important to reduce risk of obesity (Manger, 2012; Sherry; Story, 2012; Strong et al.; Whetstone, 2012). However, there is lack of strong evidence as to how to assist children and youth to develop healthful behaviors to achieve and maintain healthy weight (Procter, 2007; Reilly, 2012; Waters, 2011). Research is constantly in search for effective interventions.

Role of theory in designing interventions

In order to develop effective interventions to modify diet and physical activity behaviors, research has shown that use of behavior change theories are highly valuable (Hochbaum et al., 1992; Jackson, 1997; Reilly, 2012). Behavioral theories provide information on why people behave the way they do, and how to modify these behaviors. Hence, it is beneficial to take advantage of this information when developing a program. Additionally, theory assists program developers in creating cohesive and comprehensive interventions by providing guidelines for the formation of program goals and components (Baranowski, 2009; Cerin, Barnett, & Baranowski, 2009; Contento, 2008; Hochbaum et al., 1992; Jackson, 1997). Several theories have shown promise in changing behavior in both adults and in children. These include: Social Cognitive Theory (SCT) (Bandura, 1969), Self Determination Theory (SDT) (Ryan & Deci, 2000), and

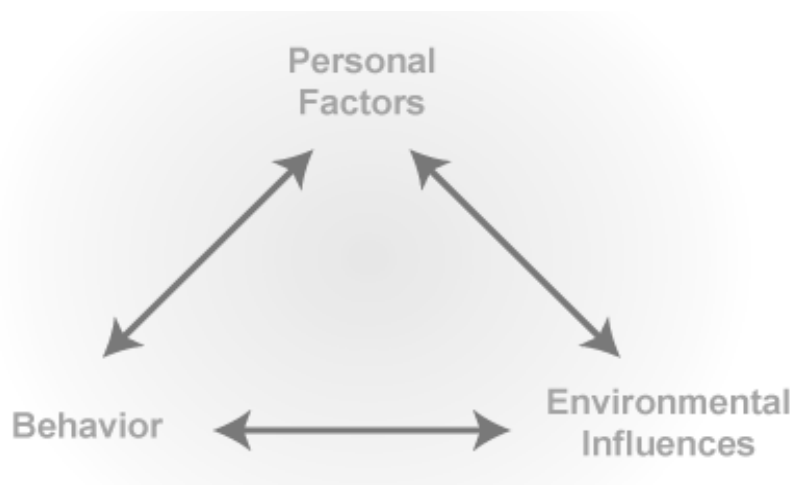
Behavioral Inoculation Theory (BIT) (McGuire, 1961) etc. While alone most theories provide important insights into limited aspects of behavior change but when used in combinations they provide a more comprehensive framework within which behavior change interventions may be developed.

SCT and SDT that are relevant to this research are described below:

Social Cognitive Theory

The social cognitive theory proposed by Bandura explains how people acquire and maintain certain behavioral patterns, while also providing the basis for intervention strategies. The three factors environment, people and behavior are constantly influencing each other. Social cognitive theory favors a model of causation involving triadic reciprocal determinism. In this model of reciprocal causation, behavior, cognition and other personal factors, and environmental influences all operate as interacting determinants that influence each other bi-directionally. This theory has been extensively used in health promotion and disease prevention and posits a multifaceted causal structure in which self-efficacy beliefs operate in concert with cognized goals, outcome expectation, and perceived environmental impediments and facilitators in the regulation of human motivation, action, and well-being. Perceived self-efficacy is a key factor in the causal structure because it operates on motivation and action both directly and through its impact on the other determinants. Social cognitive theory addresses the socio-structural determinants of health as well as the personal determinants. A comprehensive approach to health promotion requires changing the practices of social systems that have

Figure 1: Social Cognitive Theory



widespread detrimental effects on health rather than solely changing the habits of individuals. People's beliefs in their collective efficacy to accomplish social change, therefore, play a key role in the policy and public health perspective to health promotion and disease prevention (Bandura, 1998).

SCT provides a framework for designing, implementing and evaluating programs and appears to be a widely used choice for a theory-based obesity prevention intervention based the on literature (Baranowski, Perry, & Parcel, 2002). Core determinants of SCT related to promotion of healthy behaviors include: behavioral capability of health practices and risks, perceived self-efficacy or confidence that one can perform the health behavior, self-regulatory skills such as problem solving and goal setting and specific strategies to realize these goals, and perceived environmental facilitators and impediments to making health behavior changes (Bandura, 2004). Additionally, SCT cites modeling as a method to increase behavioral capability and skills, which could then in turn enhance self-efficacy beliefs (Thompson, Baranowski, Cullen, et al., 2007). Childhood obesity prevention interventions aimed at changing youth diet and physical activity behaviors have employed these constructs with some success (Baranowski,

Baranowski, et al., 2003; Baranowski et al., 2000; Contento et al., 2010; Evans et al., 2006; Gortmaker et al., 1999; Thompson, Baranowski, Cullen, et al., 2007).

SCT is considered an interpersonal theory because its constructs address not only within the individual but also into interpersonal relationships through factors such as role-modeling and external reinforcements (Baranowski et al., 2002). These multiple levels of constructs allow for the unique concept of reciprocal determinism, which is the notion that changes within a person, behavior or environment, can further affect any level, and reverberate to have continuing effects (Baranowski et al., 2002). This has relevance for obesity prevention interventions as changing behavior in a child can have further impact on their peers and parents and vice versa thus creating more avenues for change than just the target population.

Self Determination Theory

SDT posits that interpersonal contexts that facilitate satisfaction of the basic psychological needs for competence, autonomy, and relatedness enhance autonomous motivation. Autonomous motivation predicts persistence and adherence and is advantageous for effective performance, especially on complex behaviors that involve deep information processing and has to be pursued long term. Autonomous motivation consists of both intrinsic motivation and well-internalized extrinsic motivation.

Intrinsic motivation involves doing a behavior because the activity itself is interesting and spontaneously satisfying. When intrinsically motivated, people perform activities because of the positive feelings resulting from the activities themselves. People are interested in what they are doing, and they display curiosity, explore novel stimuli, and work to master optimal challenges. Extrinsic motivation, in contrast, involves engaging in an activity because it leads to some separate consequence such as to obtain a tangible reward or to avoid a punishment. However,

research shows that some forms of extrinsic motivation can still be autonomous. SDT emphasizes that if an individual experiences support for basic psychological need satisfaction, he is more likely to internalize the behavior even if it is performed due to some tangible rewards.

A continuum exists between extrinsic motivation that is entirely motivated by external causalities to extrinsic motivation that is internally motivated, to complete innate intrinsic motivation where behavior is performed only for enjoyment. The least effective type of internalization is referred to as introjection. It involves people taking in an external contingency, demand, or regulation but not accepting it as their own. The second type of internalization is referred to as identification and involves people accepting the importance of the behavior for themselves and thus accepting it as their own. When people have identified with a regulation, they engage in the behavior with a greater sense of autonomy and thus do not feel pressured or controlled to do the behavior. Finally, integration is the third type of internalization, in which people have succeeded at integrating an identification with other aspects of their true or integrated self. They reciprocally assimilate a new identification with their sense of who they are. Integration represents the fullest type of internalization and is the means through which extrinsically motivated behaviors become truly autonomous or self-determined.

The conception of internalization and types of regulation have shifted the primary differentiation within SDT from a focus on intrinsic versus extrinsic motivation to a focus on autonomous versus controlled motivation. External and introjected regulations are forms of controlled motivation, whereas identified/integrated and intrinsic regulation are forms of autonomous motivation. Of course, all types of autonomous and controlled motivation are types of motivation that reflect a person's intention to act, although they may result in different quality outcomes (Deci & Ryan, 2008).

According to SDT, feedback and communication that support an individual's belief that they are competent and have choice in their behavior can foster internal motivation. However, feedback such as threats or deadlines, or rewards (including expectation of monetary rewards), can cause the individual to perceive an external causality for the behavior and lose internal motivation (Ryan & Deci, 2000). Consequently, interventions based on SDT promote competence by encouraging feedback, presenting choices that allow the individual to feel in control of their decisions, and allowing individuals to attach values to their goal behaviors to develop personal importance for such action. Studies in youth nutrition and physical activity have successfully employed and validated concepts from SDT (Gillison, Standage, & Skevington, 2006; Resnicow et al., 2008; Standage, Duda, & Ntoumanis, 2005)

Variables that mediate behavior change

The mediating variable model has been proposed as a framework both for designing interventions and for understanding how interventions work to promote change in diet and physical activity behaviors. Mediating variables are in a cause-effect sequence between an intervention and an outcome (Baranowski, Cullen, Nicklas, Thompson, & Baranowski, 2003). The mediating variable model of behavior change posits that intervention programs attain behavior change by inducing changes in mediating variables that come from the ecological, social, and psychological theories, and changes in these mediating variables induce relatively stable changes in behaviors in an approximately linear fashion (Baranowski, Ester, & Baranowski, 2009; Baranowski, Lin, Wetter, Resnicow, & Hearn, 1997). Implications of the mediating variable model are that (a) behaviors need to be selected that are maximally and causally related to the health outcomes of concern (or else the health problems will not change); (b) ecological, social and psychological mediators (in the context of known biology) need to be

selected that are maximally and causally related to the behavior (otherwise change in mediators will not result in sufficiently large changes in behavior); (c) mediators need to be selected that are highly predictive of the behavior (otherwise substantial changes in the mediators may result in only small or no changes in the behavior); and (d) intervention procedures need to be identified or developed that effectively manipulate the mediators at acceptable levels (or else participants will not receive an effective intervention dose). Dietary and physical activity behavior change interventions that are designed accordingly would maximize the likelihood of success (Baranowski et al., 2009).

Mediators for obesity interventions for children and adolescents

A recent review on school based energy balance interventions for children and adolescents found strong evidence for self-efficacy and moderate evidence for intention as mediators of physical activity interventions. Indications were found for attitude, behavioral capability and habit strength to be mediators of dietary behavior interventions (Cerin & Mackinnon, 2009; van Stralen et al., 2011). These mediators come from Social Cognitive and Self Determination Theories.

Self-efficacy is the confidence that one can perform a certain behavior (Bandura, 2004). Both personal mastery of the behavior through practice, and observation of others successfully performing the behavior may increase self-efficacy (Thompson, Baranowski, Cullen, et al., 2007). Many studies have tested self-efficacy as a mediator of both physical activity behavior change and dietary change in youth and many have shown positive associations (Dishman et al., 2004; Lubans & Sylva, 2009; Reynolds, Yaroch, Franklin, & Maloy, 2002). Thus, by targeting intervention activities at increasing self-efficacy through modeling the goal behaviors and allowing children to practice the goal behaviors, we may be able to effect a greater ultimate

behavior change. Behavioral capability has been tested as a mediator more with dietary change than with physical activity change. Some studies have shown behavioral capability to be a mediator for dietary change, often with increasing consumption of fruits and vegetables (Lytle et al., 2003; Reynolds et al., 2002). Self-regulatory skills facilitate an individual's control over their behavior through skills such as goal setting, problem solving by overcoming barriers, and the use of implementation strategies (Thompson, Baranowski, Cullen, et al., 2007). Both SCT and SDT assert that this personal regulation of behavior and control over one's actions is important for behavior change. SDT posits that control, or choice, fosters the individual's internal motivation to perform the behavior and thus makes the individual more likely make the behavior change (Ryan & Deci, 2000). Goals influence behavior by calling individuals to action, giving them direction towards this action and encouraging persistence of effort, as well as by assisting in the development of newfound implementation and behavioral strategies to realize the goal (Dishman et al., 2006). Studies have proposed that goal setting, and other self-regulatory skills such as overcoming barriers and creating implementation strategies, can mediate physical activity and dietary change in children (Lytle et al., 2003). Thus interventions should allow participants to have control and feel they have choice by allowing them to select goals, create implementation strategies, and problem solve overcoming barriers. A review of literature by Cerin et. al has suggested that for children and adolescents self-efficacy (perceived control), outcome expectation (attitude) and habit strength have emerged as the most consistent mediators of behavior change among various studies (Baranowski et al., 2009; Cerin & Mackinnon, 2009). For physical activity, self-efficacy emerged as the strongest mediator in most interventions with children and adolescents (Lubans et al., 2008; van Stralen et al., 2011).

Schools as potential targets for obesity prevention

With more than 54 million children in attendance daily, the nations' schools offer many opportunities for developing strategies to prevent childhood obesity. Children spend roughly a third of every weekday, equivalent to about 32.5 hours a week, in schools (Swanbrow, 2004). While they are there, they can consume up to two meals, plus snacks. They have many potential avenues for recreation and physical activity. They also take courses in health education and receive health services of various kinds at school (Story et al., 2006)..

Richter et al (Richter et al., 2000) performed an extensive review of the environmental factors that relate to physical activity and nutrition in youth. They considered the key factors to be the number and type of exercise programs, exercise facilities, policies, types of health promotion activities, presence or absence of certain foods, ways in which food is displayed, and the presence of positive or negative consequences of physical activity and eating. In addition, teacher influences and role modeling and the social network affect the psychosocial culture and the outcome expectation (social) of the school. In addition, school-based learning activities provide a behavioral capability base and rationale for change (Cullen et al., 1999; Cullen et al., 2007; Healthy Study Group, 2010; Story, Lytle, Birnbaum, & Perry, 2002). Both retrospective and prospective research show that well-designed and implemented programs are effective in promoting a wide range of beneficial health behaviors among adolescents, including improvement in nutrition practices and enhancing exercise self-efficacy (Story et al., 2002)

Rationale for middle school-based interventions

Middle school represents a strategic time and place in which to study interventions to influence risk factors for obesity. Children in the sixth to eighth grades (middle school) are

generally 11-14 yrs old and in early adolescence. This is a time of both physical and metabolic as well as emotional and mental growth and development. Diet and physical activity behaviors are in flux during this period, and this transition represents an optimal opportunity to encourage healthier behaviors. Students at this age are developmentally capable of increasing and assuming personal responsibility for behavior change and choices (Healthy Study Group, 2010).

Some popular school based obesity prevention interventions targeted towards middle school students (the target population of this study) are discussed below:

Planet Health (1999): Planet Health was designed to reduce obesity by increasing energy expenditure while promoting key dietary behaviors consistent with dietary guidelines. The intervention focused on 4 behavioral changes: reducing television viewing to less than 2 hours per day; increasing moderate and vigorous physical activity; decreasing consumption of high-fat foods; and increasing consumption of fruits and vegetables to 5 a day or more. Planet Health sessions were included within existing curricula using classroom teachers in 4 major subjects (language arts, math, science, and social studies) and physical education. It was implemented in 5 intervention schools in low-income populations in the Boston metropolitan area in Massachusetts. Students participated in this school-based interdisciplinary intervention over 2 school yrs. The intervention materials incorporated standards outlined in the Massachusetts Curriculum Frameworks, so that skills and competencies that were required in middle school were used as vehicles for conveying Planet Health messages. In classroom lessons, each theme was addressed in 1 lesson per subject (language arts, math, science, and social studies), for a total of 16 core lessons each in year 1 and year 2 (32 total). An additional lesson was developed as a 2-week campaign to reduce television viewing in households. Each lesson had a behavioral objective that fit with 1 of the 4 behavioral targets of the intervention. Physical education

materials focused on activity and inactivity themes and included student self-assessments of activity and inactivity levels and goal setting and evaluations for reducing inactivity, replacing inactive time with moderate and vigorous physical activities of their choice and consisted of thirty 5-minute intervention micro-units. Constructs from Social Cognitive Theory and Behavioral Choice Theory were used to develop the intervention.

The intervention was evaluated by a randomized controlled trial. Five schools that received the intervention were compared against five control schools from the same area. About 1295 students in Grade 6 and 7 participated in the trial. Outcomes were assessed using pre-intervention and follow-up measures that included prevalence, incidence, and remission of obesity as the primary outcome. In addition, the trial also measured television, activity, and diet measures (secondary outcomes). These measures were obtained via a student Food and Activity Survey.

Significance: Planet Health decreased obesity prevalence and increased obesity remission among girls but not among boys. Reductions were found in students' television viewing time for both boys and girls, and girls in the intervention schools experienced increases in fruit and vegetable consumption by 0.2 servings, and a reduced increase in dietary energy intake over the 2 school yrs. Among girls, reductions in television viewing time predicted reductions in obesity, mediating the intervention effect and providing evidence for this causal pathway.

Limitations: The study did not measure theory variables. Hence, it was unable to answer if the chosen theories were appropriate to explain the changes in behaviors (Gortmaker et al., 1999).

Middle School Physical Activity and Nutrition (M-SPAN) study (2003): The objective of this study was to evaluate the effects of environmental, policy, and social marketing interventions on physical activity and fat intake of middle school students on campus (McKenzie, 2004). Twenty-four middle schools in San Diego, California, were randomly assigned to intervention or control conditions. The intervention was based on the ecological model of health behavior. The primary aims of the intervention were to (1) increase total energy expenditure from physical activity by school students, and (2) decrease grams of total and saturated dietary fat purchased at, or brought to school by students.

Physical activity interventions were designed to increase physical activity in physical education classes and throughout the school day. Nutrition interventions were designed to provide and market low-fat foods at all school food sources, including cafeteria breakfasts and lunches, a la carte sources, school stores, and bag lunches. School staff and students were engaged in policy change efforts, but there was no classroom health education. The intervention continued for 2 yrs. Primary outcomes (decreasing total and saturated fat purchase and increasing physical activities) were measured by direct observations and existing records. Results showed that there was no change in the consumption of low fat food, but the intervention group significantly showed increase in physical activity. Boys (not girls) in the intervention group also showed significant decrease in BMI (McKenzie, 2004).

Significance: The study stressed on the role of school environment and policy interventions as an important part of obesity prevention program in schools.

Limitations: The intervention focused on fatty food purchased and brought to school. It did not measure the actual consumption of these foods, and failed to take into account individual and interpersonal factors associated with eating among adolescents.

The Teens Eating for Energy and Nutrition at Schools (TEENS) Study (2004): The TEENS study was conducted with the goal of developing and evaluating the effectiveness of classroom, school-wide, and family programs to increase fruit and vegetable intake and decrease fat intake among seventh and eighth graders to reduce their future risks of cancer.

The primary outcome measures for evaluating the effectiveness of TEENS were student-level intake of fruits, vegetables, and energy from fat based on 24-hour dietary recalls. Three channels were selected for delivery of the intervention that included classroom, family, and school-wide components. The classroom component was based on constructs from the Social Cognitive Theory and consisted of 10 behaviorally based nutrition education lessons in each of the seventh and eighth grades. In both yrs of implementation the TEENS curriculum included self-monitoring, goal setting, hands-on snack preparation, and skill development for choosing healthy foods and for overcoming barriers to making healthful choices. The TEENS family component consisted of three newsletters and sets of behavioral messages in forms of coupons delivered in both the seventh and eighth grades in conjunction with the TEENS curriculum. The school-wide channel included working with district food service directors and local school food service managers and staff to increase the offerings and promotion of fruits and vegetables (the emphasis in seventh grade) and healthier snacks à la carte (the emphasis in eighth grade) and to create school-wide councils to help foster a school environment where a healthy food choice was the easier and more normative food choice.

Outcome evaluation of this 2-year study used a randomized controlled trial with over 2000 students from 16 schools in low-income areas in Minnesota. Dietary data was collected

using 24-hour recalls. A modified and validated version of the fruit and vegetable screener from the Behavioral Risk Factor Surveillance System was also used (Lytle et al., 2004).

Significance: The results of this study were not too promising. The students showed some improvement in fruit and vegetable consumption after one year, but the results were not maintained at the end of the second year. However, TEENS was one of the first multi-component school-based studies focusing on nutritional outcomes conducted in middle schools.

Limitations: The study did not intend to evaluate the mediators of behavior change.

The Dutch Obesity Intervention in Teenagers (DOiT) Study (2008): This study was conducted in 20 middle schools in The Netherlands. It targeted adolescents' ages 11-13 yrs and aimed at preventing excessive weight gain. More than 1000 (n=1091 at baseline) students participated in the study. The intervention focused on the following health behaviors: (1) reduction of the consumption of sugar-sweetened beverages, (2) reduction of energy intake derived from snacks, (3) decrease of levels of sedentary behavior, and (4) increase of levels of physical activity (i.e. active transport behavior and sports participation). The intervention program consisted of an individual classroom-based component (an educational program covering 11 lessons in both biology and physical education classes), and an environmental component (encouraging and supporting changes at the school canteens, as well as offering additional physical education classes).

The intervention was evaluated with regard to effects on body composition (primary outcome measure), and behavior, behavioral determinants, and aerobic fitness (secondary outcome measures). The effectiveness of the intervention program was evaluated using a cluster randomized controlled trial design, with measurements at baseline, after eight, twelve, and

twenty months.

Questionnaires contained frequency questions regarding the four identified risk behaviors: (1) consumption of SSBs, (2) consumption of high- sugar/high-fat content snacks, (3) sedentary behavior (watching television and using the computer), (4) low levels of physical activity (i.e. active transport to school and participation in physical activity and sports).

Questions on personal and social environmental determinants of each of the risk behaviors included questions on attitude, subjective norm, perceived behavioral control, personal barriers, intention and habit-strength.

The determinant variables were based on the Environmental Research framework for weight Gain prevention (EnRG) framework, an integrative framework that applies insights from Dual-Process Theory, the ANGELO (Analysis Grid for Environments Linked to Obesity) model, Theory of Planned Behavior, and Habit theory⁵. Most variables were measured on five-point Likert scales.

Significance: The DOiT-intervention reduced SSB consumption among both boys and girls. Boys in intervention schools improved their attitude towards decreasing sugar- sweetened beverage consumption, while this behavior became less of a habit. Thus, attitude and habit strength emerged as significant mediators of the DOiT-intervention's effect on sugar sweetened beverage consumption among boys. It is among the few studies that have measured the effects of mediators on behavior change.

Limitations: The study did not show any intervention effect on hypothesized mediators was found nor evidence of any mediating mechanisms (Chin A Paw et al., 2008; Singh et al., 2006).

⁵ Explanation of these theories is beyond the scope of this review.

Choice, Control & Change (C3) Study (2010): This study was conducted to examine the impact of a curriculum intervention on the adoption of energy balance related behaviors of decreasing sweetened drinks, packaged snacks, fast food, and leisure screen time, and increasing water, fruits and vegetables, and physical activity, and on potential psychosocial mediators of the behaviors.

The intervention consisted of twenty-four C3 lessons that used science inquiry investigations to enhance motivation for action based on social cognitive and self-determination theories to increase personal agency and autonomous motivation to take action. The goal of the curriculum was to assist middle school youth to acquire motivations and skills to become both competent navigators of the current food system and sedentary environment and agents in creating their personal food and activity world.

The outcome evaluation consisted of ten middle schools randomly assigned within matched pairs to either intervention or comparison/delayed control conditions. Students (n=1136) were from low-income New York City neighborhoods.

Two self-report instruments to measure energy balance related behaviors targeted by the curriculum and potential psychosocial mediators of the behaviors were developed, validated and used to measure outcomes.

Results showed that students in intervention schools compared to the delayed intervention controls reported consumption of considerably fewer sweetened drinks and packaged snacks, smaller sizes of fast food, increased intentional walking for exercise, and decreased leisure screen time, but showed no increases in their intakes of water, fruits, and vegetables. They showed substantial increases in positive outcome expectation about the behaviors, self-efficacy, goal intentions, competence, and autonomy.

Significance: The C3curriculum was effective in improving many of the targeted behaviors related to reducing obesity risk, indicating that combining inquiry-based science education and behavioral theory is a promising approach in designing obesity prevention interventions.

Limitations: The study did not measure actual weight changes among students. It focused primarily on behavior change based on self-reports.

The HEALTHY Study (2011): The HEALTHY study was designed to respond to the alarming trends in increasing rates of overweight, obesity, and type 2 diabetes mellitus in youth. It was a five-semester middle school-based intervention program that integrated multiple components in nutrition, physical education, behavior change, and social marketing-based communications.

The HEALTHY nutrition intervention component was designed to implement changes in the quantity and nutritional quality of food and beverages available to students throughout the total school food environment with an emphasis on changes likely to reduce the risk of overweight, obesity, and type 2 diabetes. The total school food environment included cafeteria meals and after-school snacks provided through federal meal programs as well as a la carte venues, such as snack bars and school stores, vending machines, fundraisers, and classroom parties and celebrations. The intervention goals and strategies targeted: 1) high-fat foods, 2) fruits and vegetables, 3) high-fat/calorie snacks and desserts, 4) added-sugar beverages, and 5) fiber-rich foods including grain-based foods and legumes. The intervention also aimed to improve students' dietary intake outside of the school environment through messages about

healthy eating, cafeteria-based educational events, taste tests to introduce new food items, and nutrition education provided in the classroom and through parent newsletters.

The outcome evaluation of HEALTHY was a cluster-randomized study in 42 public middle schools. The study followed students from sixth (ages 10-11) through eighth grade (ages 13-14). All intervention components were delivered over five semesters (second semester of 6th grade, both semesters of 7th grade, and both semesters of 8th grade), and each semester's activities focused on a specific theme: consuming water versus sweetened beverages; increasing physical activity and reducing sedentary behavior; consuming high quality versus low quality foods; understanding energy balance; and strength, balance and making choices for life.

The primary outcome of the study was to measure changes in BMI, fasting glucose and insulin among students. Dietary measures were secondary outcomes. Students self-reported their dietary intake using the Block Kids Questionnaire, a semi-quantified food frequency questionnaire (FFQ) that asks about consumption of approximately 100 food items during the past week where portion sizes are elicited using a serving size visual. Data was also collected for physical activity/inactivity, and fitness level.

Significance: The reported average daily fruit consumption was 10% higher at the end of the study in the intervention schools than in the control schools. The reported water intake was approximately 2 fluid ounces higher in the intervention schools than in the controls. However, there were no significant differences between intervention and control for mean intakes of energy, macronutrients, fiber, grains, vegetables, legumes, sweets, sweetened beverages, and higher- or lower-fat milk consumption (Siega-Riz et al., 2011). There was a decrease in the primary outcome of the combined prevalence of overweight and obesity in both the intervention

and control schools, with no significant difference between the school groups. The intervention schools had greater reductions in the secondary outcomes of BMI z scores, percentage of students with waist circumference at or above the 90th percentile, fasting insulin levels, and prevalence of obesity. Similar findings were observed among students who were at or above the 85th percentile for BMI at baseline (HEALTHY Study Group et al., 2010).

Limitations: The study did not measure any psychosocial mediators of behavior change although theories were used in designing the HEALTHY intervention.

Table 1 summarizes the middle school based interventions that have been described above.

Table 1: Summary of middle school-based interventions to prevent childhood obesity

Intervention Title, Author, Year	Study Design, Participants	Theories	Behavioral focus	Methods	Outcomes
Planet Health					
Gortmaker et.al, 1999,	Randomized control trial (RCT) (5 intervention, 5 control schools) N=1295, grades 6-7, 4 public schools in MA	Social Cognitive theory	Decrease consumption of high-fat foods, increase fruit and vegetable intake. Decrease television viewing, and increasing moderate and vigorous physical activity.	16 classroom lessons carrying Planet Health messages in year1 and year-2 (32 total), 1 lesson per subject (language, maths, science, and social studies). In addition 2-week campaign to reduce TV viewing in the household. PE materials focused on activity and inactivity themes and included self assessments of activity, goal setting and evaluations of reducing inactivity, replacing inactivity time with physical activity	Prevalence of obesity decreased among girls, remission of obesity among obese girls, but not boys. The intervention reduced TV hrs among both boys and girls, increased intake of fruit and vegetable
M-SPAN					
McKenzie et. al, 2004	RCT (12 intervention, 12 control schools) N=25,000, grades 6-8, 24 public middle schools in Southern California	Ecologic model of Health Behavior	1. Increase total energy expenditure from physical activity by school students, and 2. Decrease grams of total and saturated dietary fat purchased at, or brought to school by students.	The intervention targeted to change school environment to promote behavior changes. For the nutrition component the schools breakfast and lunch menus were changed, staff were trained to encourage them to cook low fat options, school vendors were targeted so that they brought food low in fat. For increasing physical activity regular physical education classes were promoted, training was provided to the staff and children were encouraged to be present in gym classes and in the physical	Intervention group significantly improved PA, no changes in consumption of low fat foods, only the boys in the intervention showed significant decrease in BMI

education sessions				
TEENS				
Lytle et. al, 2004	RCT (8 intervention, 8 control schools)	Social cognitive theory	Increase intakes of fruits, vegetables, and lower fat foods.	No changes in primary outcomes. Positive effects were seen only for a food choice score.
	N=2883, grades 7-8, 16 middle schools in Minnesota			
				Three channels of intervention delivery: classroom, family, and school-wide components.
				The classroom component included 10 behaviorally based nutrition education lessons in each of the seventh and eighth grades.
				The family component consisted of three newsletters and sets of behavioral coupons in both the seventh and eighth grades delivered in conjunction with the TEENS curriculum.
				The school-wide channel included working with district food service directors and local school food service managers and staff to increase the offerings and promotion of fruits and vegetables (the emphasis in seventh grade) and healthier snacks à la carte (the emphasis in eighth grade) and to create school wide councils to help foster a school environment where a healthy food choice was the easier and more normative food choice.
DOiT				
Chin. A. Paw et. al, 2008	RCT	Dual-Process Theory, the ANGELO (analysis grid for environments linked to	(1) Reduction of the consumption of sugar-sweetened beverages, (2) reduction of energy intake derived from snacks, (3) decrease of levels of sedentary behavior, and (4)	Intervention reduced SSB consumption among both boys and girls.
	N=1091, 20 middle schools in The Netherlands, age: 11-13 yrs			Boys improved their attitude towards decreasing sugar-sweetened beverage

		obesity) model, Theory of Planned Behavior, and Habit theory.	increase of levels of physical activity (i.e. active transport behavior and sports participation).	(encouraging and supporting changes at the school canteens, as well as offering additional physical education classes).	consumption, while this behavior became less of a habit.
Choice, Control & Change					
Contento et. al, 2010	RCT (5 intervention, 5 control) N=1136, 10 middle schools in NYC, primarily seventh and eighth graders, age 11-13 yrs	Social Cognitive and Self-Determination Theories	Decrease sweetened drinks, packaged snacks, fast food, and leisure screen time, and increase water, fruits and vegetables, and physical activity, and the potential psychosocial mediators of the behaviors.	Intervention consisted of 24 lessons based on SCT and SDT, implemented in 8-10 weeks. It examined the impact of a curriculum intervention on the adoption of energy balance related behaviors.	Students in the intervention consumed fewer sweetened drinks and packaged snacks, smaller sizes of fast food, increased intentional walking for exercise, and decreased leisure screen time, but showed no increases in their intakes of water, fruits, and vegetables. They showed substantial increases in positive outcome expectation about the behaviors, self-efficacy, goal intentions, competence, and autonomy.
HEALTHY Study					
Siega Riz et.al, 2000	RCT (21 intervention, 21 controls) N=3908, 42 public middle schools at seven centers (6 states) in US. Age: 10-14 yrs.	Social Cognitive theory	Increase intake of dietary fiber, fruits, and vegetables and decrease intake of high fat and high sugar foods. Increase intake of water and low fat milk and decrease intake of added sugar beverages. Increase amount of physical activity and decrease amount of sedentary behavior.	It is a five-semester program that integrated multiple components in nutrition, physical education, behavior change, and social marketing-based communication	There was a 10% increase in fruit consumption and 2 fluid ounces increase in water consumption in the intervention as compared to the controls. There were no significant differences between intervention and control for mean intakes of energy, macronutrients, fiber, grains, vegetables, legumes, sweets, sweetened beverages, and higher- or lower-fat milk consumption.

Summary of middle school based interventions

School-based interventions to change diet and physical activity have shown some success in promoting healthy eating and physical activity behaviors. These intervention programs have often been successful at improving psychosocial factors (behavioral capability, self-efficacy, intentions etc.) related to diet and physical activity (Gittelsohn & Kumar, 2007).

SCT has emerged as the most common conceptual framework driving both the intervention and evaluation strategies of the programs. This may be due to the fact that SCT is based on a learning theory and successful programs have often targeted older children who are thought to be in a better position to internalize and act upon new concepts and behaviors (Gittelsohn & Kumar, 2007).

Recommendations

Schools are an important part of the social environment that shapes children's dietary and physical activity patterns and therefore play an integral role in promoting positive changes in behavioral capability, attitudes, and behavioral modifications. However, school based interventions have not been able to attenuate the obesity epidemic. A recent review of school based interventions for childhood and adolescent obesity by Sharma has recommended that the nutrition behaviors of increased fruit and vegetable consumption, decreased fat intake, decreased consumption of carbonated drinks, adequate consumption of water and restricting portion sizes are important aspects and should be included in interventions. In addition reducing TV watching has also been found to be a modifiable behavior that must be addressed in future interventions aimed at decreasing childhood and adolescent obesity. There is also a need for all interventions to be based on behavioral theories. Further interventions must clearly measure the constructs they have reified before and after the intervention that will give greater confidence in the

intervention and the link the results to the theoretical approach. There is need to develop psychometrically robust instruments that are able to measure the changes in constructs of various behavioral theories being used by intervention researchers (Sharma, 2006).

Addressing the gap

Logistical concerns are also known to impede full implementation of the programs and need to be considered. Though school settings are promising locations to promote healthy nutrition to children, but barriers such as the need to expend resources for staff trainings and frequent staff turnover hamper successful implementation (Kelder, 2005). Other barriers include lack of nutrition resources inside classrooms and inadequate teacher training in nutrition education. Innovative approaches are needed to mitigate these barriers while providing educational fidelity, seamless implementation within the school day, and minimal teacher oversight. Educational video games may contribute to a solution. During the last decade, increasing research and application of educational games has demonstrated a positive impact on children's cognitive development, dietary habits, and physical activity behavior (Beasley et al., 2012). However, few evidence-based educational games are currently available for middle school children.

Digital media and obesity prevention

Media use among children and adolescents

With technology allowing nearly 24-hour media access as children and teens go about their daily lives, the amount of time young people spend with entertainment media has risen dramatically. United States now houses the highest percentage of youth under 18 yrs of age using the internet, with approximately 93% of teens (aged 12–17 yrs old) going online (Wilson, 2010).

Only 15% of households do not have a home computer (Daley, 2009). 83% of American youth have access to at least 1 video game device in their bedroom (Biddiss & Irwin, 2010). Today, 8-18 year-olds devote an average of 7 hours and 38 minutes to using entertainment media across a typical day (more than 53 hours a week) (Kaiser Family Foundation, 2010).

Popular new activities like social networking also contribute to increased media use. Top online activities include social networking (22 minutes per day), playing games (17 minutes), and visiting video sites such as YouTube (15 minutes). Three-quarters (74%) of all 7th-12th graders say they have a profile on a social networking site (Kaiser Family Foundation, 2010).

Popularity of video games among children

Video games reach a large and diverse audience and represent a \$7 billion business in the United States (Baranowski et al., 2008). This exceeds the \$5 billion annual box office sales of the Hollywood movie industry. Nintendo, which launches 8-12 new games yearly, sold 2.2 million copies of its best seller Donkey Kong Country game in 1994 and has sold 7.4 million copies of this game worldwide (Hawn, 2009). These facts suggest this pastime has a major presence in the lives of American children.

Why use video games to prevent childhood obesity?

It has been contended that video games can displace time children could engage in playing sports and doing other kinds of physical activity. It warrants special attention here, as there is concern, not only about unintended negative consequences with increased screen time by children and teens (e.g., sedentary behavior), but also in leveraging electronic media (e.g., incentivising children and teens with video game) to combat childhood obesity when it may potentially exacerbate the problem of overweight and obesity amongst youth (Stokes, 2005).

Using video games to promote behavior change capitalizes on children's pre-existing attention and enjoyment of them. Given the fact that a child's attention is already captured by video games, research is targeted at developing games for obesity reduction that use active "new generation" style games to increase children's behavioral capability and self-care abilities. In this way time that children already spend playing video games can be simultaneously used to promote physical activity and health behavior.

Video games and learning

Most people think of video games as entertainment. There is a growing interest, however, in video games as a means to educate and train people (Durkin, 2010). *Serious game* is a term that has been used to describe video games that have been designed specifically for training and education (Annetta, 2010).

Video games also offer potential behavior change channels by embedding functional behavioral capability and change procedures such as goal setting, modeling, and skill development activities into a personally meaningful, entertaining, and immersive game environment. These video games are now popularly known as "serious video games", and are designed to entertain players as they educate, train, or change behavior (Stokes, 2005). A review conducted by Baranowski et al. have shown that "serious video games" may serve as effective behavior change channels for diet and physical activity among children and adolescents (Baranowski et al., 2008).

A review of literature by Papastergiou contends that these educational video games can be more enjoyable, more interesting, and more effective than traditional classroom learning. Electronic media have several advantages, the main one being their compelling and engaging nature that provide potentially powerful learning environments for a number of reasons such as

a) they can support multi-sensory, active, experiential, problem-based learning; b) they favor activation of prior behavioral capability given that players must use previously learned information in order to advance; c) they provide immediate feedback enabling players to test hypotheses and learn from their actions; d) they encompass opportunities for self-assessment through the mechanisms of scoring and reaching different levels; and e) the use of multi-player online games are paving ways for a new collaborative models of learning where students can learn from interacting among themselves both within the game environments (through forming online teams) and around (through sharing game related information and resources) (Papastergiou, 2009).

The transformation of video games

Over the last decade, video games have been vastly transformed into very rich and complex “virtual worlds”. These worlds are often referred to as “virtual realities (VR)”. Technology has created sophisticated simulating environments and the ability to use these environments for entertainment, education, and social interactions. The exponential increase in computing power coupled with integration of the Internet into mainstream society has given rise to numerous gaming environments and “virtual worlds”. These worlds are complex, immersive, engaging, and enabling of a wide range of activities, goals, and social behavior. They consist of (1) a digital environment that is a representation of either a real or imaginary geographic ‘place’, and (2) the requirement that a user adopt a character, avatar, or personality that resides within that world and is the means by which the user interacts (Rigby & Przybylski, 2009).

The very recent versions of games involve the Massively Multiplayer Online Games (MMOGs). These games evolved out of multi-user dungeons (MUDs). A MUD is a multiplayer computer game that typically combines text instant message chat rooms and role-playing games.

Typically, players read descriptions of their environment, objects, events, and characters in a virtual world. Users interact with other players and their surrounding by typing text commands. Many MUDs involve a fantasy world populated by mythical beings. In order to complete quests or adventures, users must complete tasks, while exploring the virtual world. The increase in computer processing speed, graphic capabilities, and broadband Internet access eventually led to the development of real-time, graphic-intensive MMOGs (Childress & Braswell, 2006).

VR technology has been acknowledged to have potential for regimen adherence, nutrition, physical activity and other behavioral lifestyle changes associated with many disease conditions including diabetes and obesity. In July 2010, The National Heart, Lung, and Blood Institute (NHLBI) convened a workshop entitled “Virtual Reality Technologies for Research and Education in Obesity and Diabetes”, in Bethesda, Maryland. The meeting explored the research potential of VR technologies for behavioral and neuroscience studies in diabetes and obesity. The two-day workshop recommended that VR technology might prove a useful tool for producing sustainable behavior change to manage weight (Ershow, Peterson, Riley, Rizzo, & Wansink, 2011).

Behavior change theories in “serious” video games

Video games have shown to impact human psychology. Social science researchers and educational game developers have targeted several constructs of behavioral theories to adopt behavior change through motivation and participation in games. Review of literature suggests; video games that are supported by theory enhances young people's self-esteem, self-efficacy, communication about health, health behavioral capability and skills, motivation to learn about health, and how these factors can influence self care behaviors and health outcomes in short term studies (Lieberman, 1995).

The Social Cognitive (SCT) and Self-Determination (SDT) theories that were discussed earlier in this review in the context of designing school based intervention programs have also been widely used for designing serious games for health and behavior change.

SDT addresses motivation to perform a behavior. In this model, motivation initiates the behavior-change pathway by influencing whether children will put themselves in situations where they are exposed to a behavior-change videogame, as well as their motivations to initiate game play, continue to play the game, and change the targeted behavior. Self-determination theory posits that behavior change is more likely maintained if it is intrinsically motivated (Rigby & Przybylski, 2009). Tailored motivational messages can be provided to the player to enhance intrinsic motivation (Brug, 1999). Entertainment virtual worlds have integrated need facilitation, goal framing, and support for autonomy recommended by SDT by casting each player in the role of a hero. Before a potential player steps into an entertainment virtual world, he or she is provided with a clear context that invites courageous and heroic action. This context encourages players by stating they have the ‘right stuff’ to succeed in the larger challenges and goals that the world and its inhabitants need. Put differently, the game ‘believes in’ the player and communicates that the player’s participation matters (i.e. the context is immediately autonomy supportive). Even during the earliest experiences in a virtual world, when the activities available are limited to learning the basic parameters of the game and how to function in it, there is the suggestion that much bigger and greater opportunities are available if the player chooses to pursue them. In other words, by building a context of the player as a heroic actor, virtual worlds establish a highly facilitative environment for intrinsic need satisfaction. Heroes blaze new trails (autonomy), heroes master the challenges before them (competence), and heroes act in

relationship with and for the betterment of the community (relatedness). In this way, the hero epitomizes self-determined functioning (Rigby & Przybylski, 2009).

SCT addresses not only motivation, but it also provides practical behavioral capability, development of skills, self-control, and the impediments and facilitators of behavior change (Bandura, 1986). The theory posits that practical behavioral capability is necessary, but not sufficient, for behavior change. For an example the environment can influence what one eats (e.g., children who have more vegetables available at home tend to eat more vegetables) (Thompson, Baranowski, Cullen, et al., 2007). Thus skills are needed to make changes in the environment, as well as self-control for limiting how much one eats. Behavioral capability games, based on mastery learning principles, can be introduced to enhance practical behavioral capability (Kulik & Kulik, 1991). Stories can be created (Baranowski et al., 2008) that immerse players and capture their attention to focus on characters who model desired behaviors and overcome barriers to behavior change (Thompson, 2010). Goal setting can be introduced to mobilize resources to achieve behavior changes and automate problem solving when problems or barriers arise.

The following section will provide a review of “serious games” in the field of education, health, and nutrition and physical activity.

Video games for education

Video games have been tried out in the field of education.

River City is a project of Harvard Graduate School of Education. River City is a multi-user virtual environment (MUVE) designed to engage teams of two to four students in a collaborative scientific inquiry-based learning experience. In this world, students conduct their scientific investigations in a virtual historical town populated by themselves, digitized historical

artifacts, and computer agents in order to detect and decipher a pattern of illness that is sweeping through the virtual community. Students manipulate a digital character, called an avatar, in order to explore the town; and they conduct virtual experiments to test their scientific hypotheses about the causes of the River City epidemics (Ketelhut, 2010). In 2002, a pilot implementation of River City was done in four middle schools in Massachusetts to determine usability, student motivation, student learning, and classroom implementation issues. Students in the control group got the same content but in a regular class format. Results showed that the students in the intervention condition had higher motivation to perform the educational tasks, had greater global self-efficacy in science and generated more scientific hypothesis as educational tasks in the game when compared to the control group (Ketelhut, 2007).

Quest Atlantis (<http://atlantis.crlt.indiana.edu/start/index.html>), a National Science Foundation (NSF) funded-project developed by researchers at Indiana University, serves as another example of a multiuser virtual environments created to immerse children (ages 9–12) in educational tasks. Users travel to virtual places (e.g., Unity, Ecology, Culture, and Healthy World) to perform educational activities (Quests). Students conduct environmental studies, research other cultures, interview community members, and develop action plans to complete their quests. It uses Vygotsky's socio-cultural constructivism model as its theoretical framework (Barab et al., 2005). Students assigned the game-based unit reported significantly higher levels of engagement, had different goals motivating their participation, and received fewer teacher reprimands to stay on task when compared to students who performed the same tasks but as regular classroom activities (Barab et al., 2012).

Another example is **Food Force** (www.food-force.com) that was created by the United Nations World Food Program in 2005. It was aimed for children between ages 8-13 yrs. It used a

intriguing story plot to aware people about hunger related problems in under developed nations. This serious game engaged users in six virtual missions to distribute food in a famine-affected country to help it recover and become self-sufficient again. The players became scientists who joined a team of United Nations experts, including a nutritionist, a logistics officer, a pilot, an appeals officer, and the director of food purchasing to pursue the game missions. The current version “Food Force-2” is available for free download from the web. The game has never been formally evaluated for its efficacy. However, the official website of the game states that “One Laptop Per Child (OLPC)⁶” is currently associated with the testing of this game.

Discover Babylon (www.discoverbabylon.org) is the result of the collaboration among the researchers at University of California, Los Angeles’s Cuneiform Digital Library Initiative, the Federation of American Scientists Learning Technologies Project, Escape Hatch Entertainment, and the Walters Art Museum in Baltimore. This multiplayer serious game is used to teach history. It features Mesopotamia’s diverse contributions in writing, mathematics, literature, and law. Located in what is now modern Iraq—Mesopotamia was the birthplace of written language, the first cities, the concept of the 360° circle and the 24-hour day, not to mention the earliest known laws and literature—yet its contributions are not well known to many Americans. Targeted at ages 8–14, *Discover Babylon* uses sophisticated video gaming strategies and realistic digital environments to engage the learner in challenges and mysteries that can only be solved through developing an understanding of Mesopotamian society, business practices, and trade. The game is designed to engage children ages 8–14 (Crewdson, 2007).

⁶ One Laptop per child (OLPC) is a non-profit organization offering an inexpensive *laptop* designed for *children* in developing countries.

Summary: The abovementioned games have not been tested rigorously by randomized controlled trials for efficacy. However, the available evaluations do show that educational games promoted learning of concepts among students including critical thinking, problem solving, and decision making, and that video games may model instructional techniques that are both engaging and effective (Hommel, 2010).

Video games for health promotion

A review of literature demonstrated that video games positively affected health behaviors and outcomes (Kato, 2010). Video games are used strategically to affect a number of issues in health among patients. The main mechanism for action often cited is their ability to increase motivation. Engaging a patient's motivation is frequently necessary in health care because patients are often required to undergo procedures or engage in behaviors that are painful and aversive on the one hand (e.g., undergoing chemotherapy) or boring and mundane on the other (e.g., taking pills, exercising on a regular basis). These procedures and behaviors are often necessary to maintain and improve health or even to cure the patient's disease. The focus of attention on an engaging distraction is also thought to be a key factor in explaining how individuals manage aversive symptoms through video game play. The repetitive nature of video game play is thought to be a key mechanism that promotes learning in games as well. Games and simulations have potential to help adolescents personalize information, forcing them to assess risks and consequences and make decisions in a hypothetical yet realistic situation. (Rosas et al., 2003).

Video games are used in positive ways to promote health and provide information to children and adolescents. They can broadly be divided into two categories: 1) Games for disease risk prevention, and 2) games for self-management.

Some examples of games for disease prevention are mentioned below:

Immune Attack (www.fas.org/immuneattack) is a serious game that was developed by the Federation of American Scientists (FAS), Brown University, and the University of Southern California in 2004 with a grant from National Science Foundation. This educational game targeted students in grades 7-12. It was created as alternative means to teach complex biology and immunology topics to students. Here, a teenage prodigy with a unique immunodeficiency had to teach his immune system how to function properly or die. The human body served as the playing field and immune cells faced off against bacterial and viral infections. Each subsequent level of Immune Attack featured a different infection with a new type of immune cell for the player to train, and the player had to scan and interact with various objects to train his immune system to fight off the invading pathogens. The newest version of the game is up on the FAS website since 2008 for free download. Researchers are in the process of evaluating the game.

An example of a disease risk prevention video game is **Health Works** developed by the AIDS education program of the New York State Department of Health for school children in grades 5-8. It was an interactive computer video program used between January 1989 and June 1992 by more than 17,000 students at 172 schools in New York State, including New York City. A study with New York City children in grades 5-8 found that this video game enhanced students' cognitive learning about AIDS (Thomas et al., 1997).

Two teenager pregnancy prevention games (**The Baby Game and Romance**) were targeted at adolescents (11-13yrs) who were sexually active and inclined to become parents during their adolescence. These games were aimed to improve adolescents' behavioral capability of adolescent parenthood and sexual behaviors, and caused attitude changes favoring delayed pregnancy and use of effective contraception (Paperny & Starn, 1989). The Baby Game provided

teenagers with the chance to experience a simulated life of a teenage parent through various scenarios and time/cost assessments. For teenagers who are sexually active or would like to be, through playing Romance could learn about contraceptive options, practice communication skills in dating situations, and experiences simulated outcomes of their decisions on sexual activities. Experimental studies showed that improvements in participants' behavioral capability about contraception, pregnancy risk, and cost of birth and child care were all significant, and related attitudinal improvements were mostly significant (Paperny & Starn, 1989).

The smoking prevention game **Rex Ronan** was designed to strengthen preadolescents' negative attitude toward smoking cigarettes (Lieberman, 2001). In this video game, users played as Dr. Rex Ronan, who could shrink and enter the body of a smoker who had many tobacco-related illnesses. They saw all kinds of detrimental effects (negative outcomes) of smoking all over the inside of the body, and control Dr. Ronan's scalpel to clean and cure the body. Besides the graphic portrayals of the physiological harm of smoking, the game also involved true-false questions about the impact of tobacco on health to test and improve users' relevant behavioral capability, as well as an attractive role model who was antismoking. Evaluation studies showed that after using the video game, the children had a better grasp of the specific consequences of smoking. The children illustrated a new resolve not to smoke with concrete examples of what would happen if they did. Focus group data from this study supported the appeal of the video game as a potential intervention to prevent smoking initiation. Children concluded that there was appeal in the intervention and even expressed the desire to continue using the video game. This game was very attractive to children, and playing increased their behavioral capability of specific negative effects of smoking on the body and their interest in learning more. Their anti-smoking

attitude was also reinforced (Burchard, 1994; Business, Entertainment, & Medical Writers National Managed Health Care, 1999; Lieberman, 2001).

To prevent sports injury in youth hockey players, a computer game named **Symptom Shock** was utilized in Canada to increase youth players' awareness of concussion symptoms (Goodman, Bradley, Paras, Williamson, & Bizzochi, 2006). This game was modeled on the popular Tetris game, and players had to make stacks of matching icons and determine whether or not the icons represented concussion symptoms in order to score more goals than the computer opponent. Goodman et al. (2006) specifically tested the impact of game content on players' behavioral capability about concussion symptoms, using both the actual game and a control version of the game with irrelevant content. It was demonstrated that the players of Symptom Shock significantly improved their behavioral capability on concussion symptoms and speed of answering related questions. In this study, participants were provided with an incentive to get involved in the game playing, which might be important to games that are not very attractive per se. They were informed that they were in a competition with other teams of the same age division for a prize based on how successfully they played the game (Goodman et al., 2006).

Video games have also been applied to improve self-management skills for coping with certain chronic diseases, such as asthma, diabetes, cancer, and so forth.

“**Packy & Marlon**”, an interactive video game designed to improve self-care among children and adolescents with diabetes. In the video game players needed to help their game characters, two adolescent elephants, manage their diabetes by monitoring blood glucose, taking proper amounts of insulin, reviewing a diabetes logbook, and finding appropriate food. Self-concept (including self-esteem and self-efficacy), social support, and behavioral capability were the key elements to be considered in the game design. In a randomized controlled field

experiment, although participants' self-efficacy for diabetes self-care did not achieve a significant change, the treatment group significantly improved their communication with parents about diabetes and self-care behaviors. Moreover, although the statistical result did not show a significant difference, urgent visits for diabetes dropped over 70% in the treatment group compared to an increase in the control group. Study participants were patients aged 8 to 16 from two separate diabetes clinics. The study found that for those who used the interactive video game for six months the diabetes related emergency room visits of patients reduced by 77 percent (Brown et al., 1997; Lieberman, 1995).

Re-Mission is a computer game including 20 missions/levels designed for young cancer patients. The game is now available in English, French, and Spanish, and free of charge to young people living with cancer. The player plays a nano robot that goes inside the body of cancer patients undergoing chemotherapy, radiation, or immunotherapy. By acting out as the nano robot inside a cancer patient body and observing how medication and chemotherapy help the body fight against cancer cells, players get to know more about cancer and become more confident in fighting the disease. Randomized clinical trial of "Re-mission" involved 375 male and female patients at 34 medical centers in the US, Australia and Canada during 2004-2005. The patients were 13 to 29 yrs old, had an initial or relapse diagnosis of a malignancy, and were undergoing treatment. The intervention significantly improved treatment adherence and indicators of cancer-related self-efficacy and behavioral capability in those who were undergoing cancer therapy (Kato et al., 2008).

Among the computer and video games with a purpose of improving self-management skills, many of them were developed for children with asthma, one of the most common chronic illnesses affecting children in the U.S. Example games are **Watch, Discover, Think and Act**,

Asthma Control, Wee Willie Wheezie, and Bronkie the Bronchiasaurus (Bartholomew et al., 2000; Homer, 2000; Shames et al., 2004; Yawn et al., 2000). Social cognitive theory was used as the theoretical foundation for developing some of these games as well as understanding their benefits, with emphases on self-regulation, self-efficacy, modeling, and so forth. For instance, in the game Watch, Discover, Think and Act, players could improve their asthma-specific self-regulatory skills through managing the game character's asthma. According to social learning theory, role models could impact people's behavior. Children were found to pay much attention to role models, especially those in their age group but a little older. This game involves an older child character serving as a role model to show the player how to manage asthma (Bartholomew et al., 2000). Another game called Bronkie the Bronchiasaurus emphasizes players' self-efficacy related to asthma (Lieberman, 2001). In this game, kids play as a dinosaur with asthma and help him save his homeland while trying to avoid asthma triggers (i.e., dust, pollen, cold viruses) and keep asthma under control. In sum, a typical scenario in self-care/management electronic games is that the player takes care of and helps the main character in the game control symptoms in various settings, so that the player's self-management skills and related behavioral capability are increased from practicing during game playing. The player's self-efficacy and received social support are important mediators for the improvements of self-care and self-monitoring. The game-based approach functioned significantly better than an educational videotape to increase users' self-efficacy for self-management, because the interactive feature of the game encouraged users' active involvement, provided them with unlimited chances of practice, and brought about more enjoyment in the learning process (Peng & Liu, 2009).

In summary, evaluation studies on the effectiveness of electronic games used for health-related purposes, almost all the games demonstrated a strong effect in teaching related behavioral

capability. Some of the studies included mediating variables such as attitude towards behavior, self-efficacy, behavioral intention, skills, and so forth as indicators of success of the games. Even though the ultimate goal of any health intervention should be the modification of behavior, most of the studies reviewed did not include behavioral outcomes as the dependent measure.

Therefore, even if the evaluation studies demonstrated that the electronic games were favored by the users and did increase behavioral capability and influence mediating variables, it is still not a guarantee that those games could influence behaviors or indeed improve health status. Therefore, the interpretation of the effectiveness of electronic games used for health-related purposes deserves more cautionary examination (Peng, 2008). The Robert Wood Johnson Foundation is encouraging a rigorous evaluation of applications on Health Games Research, including an emphasis on understanding how various game design elements contribute to efficacy in individuals with different demographic and socioeconomic backgrounds (Read & Shortell, 2011). NIH is also promoting research in “virtual reality” to change behaviors to prevent diabetes and obesity (Ershow et al., 2011).

Use of computers in the promotion of nutrition and physical activity

Increase in computer use among youth and the understanding of computers as a valuable tool in interventions has led to the development of numerous computer-based interventions for youth diet and physical activity change in recent yrs. A distinction can be drawn between interventions that use computer-tailored materials (such as pamphlets, newsletters, and reports) and interactive computerized interventions where participants actually use the technology (such as websites and handheld computers). These applications can be thought of as “first”- and “second”-generation computerized interventions, respectively (Norman et al., 2007).

We will consider the second-generation interventions only for this review.

Among the earlier second generation interventions is **The Baylor GEMS project** - a 12 week program that began with a 4 week summer day camp, followed by an 8 week internet based program; its goal was to influence energy balance (Thompson, Baranowski, Cullen, & Baranowski, 2007) (Baranowski et al., 2003). The behavioral focus was to increase fruit and vegetable consumption to 5 servings per day as well as increase water consumption to 5 or more glasses per day, thus displacing alternate high-calorie foods and beverages. The study also had participants aim to achieve 12,000 pedometer counts per day. The researchers randomized 35 eight-year old African-American girls and their caregivers from Houston, TX who had Internet availability at home, into a two-group design (19 treatment, 16 comparison) (Baranowski et al., 2003). Self-regulatory skills were emphasized. For instance, when children logged in to the internet program, they first viewed a comic, followed by a problem solving segment in which the participant helped the comic character by identifying the problem, then generating and implementing possible solutions. Next, the participant reviewed goals from the previous week, and then set new goals for the following week. Elaboration Likelihood Model guided the design of the characters and information delivered to ensure it was personally relevant (Thompson, Baranowski, Cullen, & Baranowski, 2007). Following the 12-week intervention there was no significant difference in BMI change between treatment and control groups. However, children in the intervention group did not log in to the computer sessions as instructed at home which reduced the dose of intervention (Baranowski et al., 2003). The same researchers then converted the original GEMS program to a standalone web-based program and tested this new program with 80, 8-to-10-year-old African American girls at-risk of obesity (Thompson et al., 2008b). The eight-week study followed a two-group pre-post measurement design with groups differing on incentive schedule (immediate vs delayed). This study was able to significantly increase fruit,

juice, and vegetable consumption and self-efficacy, as well as physical activity (Thompson et al., 2008b).

The **Interactive Multimedia for Promoting Physical Activity in Children (IMPACT)** intervention was a computer-based intervention delivered over 8 weeks to children in 4th Grade and their families, and attempted to increase levels of physical activity and decrease physical inactivity, limit increases in BMI, as well as alter psychosocial variables related to physical activity. The program included an 8-session multimedia game component. The software portion incorporated theory, specifically the Social Cognitive Theory into its modules through the integration of the following constructs for behavior change: outcome expectancies, behavioral capability and modeling, goal-setting, self-monitoring, reinforcement, and self-efficacy. After the 8-week period, analyses found that it was successful in decreasing BMI and percent body fat for girls but not boys, and successful in increasing self-efficacy, outcome expectation (social), and outcome expectancies in both groups (Goran & Reynolds, 2005).

Boy Scout 5A Day Badge used constructs from the SCT and the ELM to promote goal setting and problem solving for eating more fruits and vegetables. The intervention aimed at training the children in “asking skills” to increase the availability and accessibility of fruit and vegetables at home (including shopping and fast food availability); increase their preference for fruit, juice, and vegetable (FJV) by associating fun with FJV and increasing exposure to FJV through “tastings” in the troop meetings, and training scouts in FaSST (fast (and low fat), simple, safe, and tasty) recipes to be made at home for meals and snacks and on camping trips. This program also included self-control activities, including goal setting, self-monitoring, problem solving, and reward activities. These activities were provided through eight troop meeting badge activities, seven home badge activities, eight four-page comic books, and eight

newsletters. The game used comic characters for role-playing and it increased F&V intake among US boy scouts for a short term of less than 6 months (Thompson et al., 2009).

Among the latest second generation computer interventions there are three games that have been tested with some success.

Squire's Quest:

This multimedia game developed by the Children's Nutrition Center at the Baylor College, in Houston, Texas of Medicine is a 10-session computer game designed to increase children's consumption of fruit, juice, and vegetable (FJV), and thus prevent cancer and other illnesses in the long run (Baranowski et al., 2003).

Storyline: The game is set in a fantasy kingdom where the kid plays as a squire who faces challenges in his or her quest to become a knight helping the king and queen defeat invaders. The challenges for the squire were to master the skills to prepare FJV recipes to provide energy for the king and his court, with goals related to eating more nutritious FJVs. There was a wizard mentoring the squire through the challenges. It used constructs of the Social Cognitive Theory to promote goal setting, problem solving and decision making among its players.

Evaluation: The game targeted 4th graders. Researchers examined the impact of playing this game over five weeks, involving 1,578 children in a school setting. Students from 13 elementary schools from Houston Independent school district participated in this research study

Results: They found that children in the treatment group increased their FJV consumption by 1.0 serving more than those in the control group. This study demonstrated that the electronic game approach can be a very effective means to promote a healthier diet among children, because it achieved the largest increase of serving size of FJVs compared to other school-based teacher

taught interventions used a storyline; an action adventure where the players “role played” the characters of the game. (Baranowski, Baranowski, et al., 2003).

Causes of success: Several factors contributed to the success of this gaming intervention. First, the program including the game design and associated activities was based on social cognitive theory, which provides a framework to explain how people acquire and maintain behavioral patterns and the second advantage of this gaming intervention is that it involved tailoring of decision making and goal setting to children’s baseline dietary assessment and reported FJV preferences (Bandura, 1997).

Limitations: The study focused on one eating behavior that is increasing consumption of fruit and vegetables. Only personal factors that relate to behavior changes were addressed in the game. Environmental and biological factors that are important in making behavior changes at this age were not addressed.

Escape from Diab and Nanoswarm: Invasion from inner space: These two games developed by the Children’s Nutrition Center at the Baylor College of Medicine and Archimage (hereinafter called Diab and Nano, respectively) were video games designed to lower risks of type 2 diabetes and obesity by changing youth diet and physical activity behaviors.

Storyline: DeeJay, one of two protagonists, is an athletic adolescent from the present day world. While playing soccer with friends, he chases an errant ball into an abandoned building and falls through a door, where he is knocked unconscious upon landing. He awakens to find himself in Diab, a colorless land inhabited by oppressed, disenchanted people. King Etes, Diab’s evil ruler, maintains control of his subjects by promoting unhealthy diets and physical inactivity, which induce Diab inhabitants to become indolent and easier to control. Noticing the athletic-looking DeeJay is obviously not from Diab, the King’s guards immediately try to arrest him upon his

arrival. Fortunately, DeeJay is befriended by a renegade troop of Diab youth around the same age as he who help him escape the guards. They take him into hiding and tell him of a mythical “Golden City” where everyone is healthy and fit. Realizing he can’t easily return home, DeeJay decides to help his friends escape to the Golden City. He becomes their coach, introducing them to healthy eating and physical activity as a way to gain the mental acuity and physical fitness needed to outwit King Etes and “escape from Diab.” He does this through modeling and persuasive dialogue. Unbeknownst to DeeJay and his newfound Diab friends, King Etes is aware of their plot and tries to foil their attempt to escape. In the final level, a showdown occurs among DeeJay, his friends, and King Etes. The players “role played” the character named “DeeJay” to alter the behaviors of other characters in the game. “Nanoswarm: Escape from inner space” used a similar storyline but different game characters (Thompson, Baranowski, Cullen, et al., 2007).

Evaluation: Both games targeted middle school students. A two-group randomized control trial was conducted. The assessments occurred at baseline, immediately after Diab, immediately after Nano, and 2 months later. 133 children aged 10–12 yrs, initially between 50th percentile and 95th percentile BMI participated in the study. The children were recruited primarily with advertisements on a radio station whose listening audience included parents of children in the targeted age groups from ethnic minority communities (African-American, Hispanic).

Results: Children playing these video games increased fruit and vegetable consumption by about 0.67 servings per day, but not water and physical activity, or body composition. The study did not show changes in the hypothesized psychosocial mediators.

Success: The games were based on several theories including social-cognitive theory, self-determination theory, behavioral inoculation and transportation theories, and the Elaboration Likelihood Model. It focused on a behavioral objective of getting the players to set goals to eat

3-5 servings of vegetables per day and exercise at least 60 minutes per day. The game used a storyline with characters that had youth appeal. It imparted behavior specific behavioral capability in the form of mini-games. The goal setting process was elaborate and achieved through multiple steps that included formation of both a goal and implementation intention, connection of the goals to personal values, and inoculation against threats to goal attainment. Autonomy was provided to the players by offering them numerous choices throughout goal setting (Baranowski et al., 2011).

Limitations: The intervention focused on increasing fruit and vegetables, water, and physical activity only, but did not target decreasing the intakes of sweetened beverages, and processed packaged snacks that are highly consumed at this age.

Fritter Critters: This game developed by Megazoid Games (Collegeville, PA), is an online videogame intended for use in schools for children 8–12 yrs old for improving healthy diet and activity in elementary school students.

The game had 17 quests to enhance motivation for game playing, help master the game basics (e.g., visit the grocer, purchase foods), and increase nutrition and activity behavioral capability (e.g., fill healthy bars without filling unhealthy bars). The game displayed meters representing the Critter's health and diet. The health meter changed based on the Critter's diet and physical activity. The diet meters represented daily nutritional requirements, based on the USDA recommendations for children 8–12 yrs old, and filled as the player fed the Critter. To feed the Critter, food had to be purchased at a grocer or restaurant or harvested for free from the garden. Players could access nutritional information, which came from the USDA Food and Nutrient Database for Dietary dataset. Players could create recipes, which they could cook for the Critter. Players could feed their Critters the meal or sell it to the restaurant for profit. Critters could

compete in the shot put or foot race. Although players could manually help their Critter perform better, successes were linked to the Critter's health meter (Schneider et al., 2012).

Evaluation: In October and November 2011, fifth grade students ($n=97$) from a school in central Massachusetts played the game for 1 week during their health class. Measures of nutrition and activity behavioral capability, attitudes, and self-efficacy were completed prior to playing the game and again on the final day along with a videogame acceptability questionnaire.

Results: The videogame was highly acceptable to participants as measured by the acceptability questionnaire mean ratings. Significant increases in positive attitudes toward healthy eating ($P<0.001$) and healthy eating self-efficacy ($P=0.02$) and marginally significant increases in nutrition behavioral capability ($P=0.08$) were observed.

Significance: This study demonstrated that a health videogame designed to increase healthy eating and activity was feasible to be used in health class and was highly acceptable and resulted in increased nutrition behavioral capability, positive attitudes toward healthy eating, and healthy eating self-efficacy. It won 2nd place in the U.S. Department of Agriculture (USDA)/Michelle Obama 2010 for Healthy Kids contest.

Limitations: The game measured psychosocial mediators but the study did not clearly state the use of theories in its making. It involved creature care as a way to learn about healthful eating and physical activity but did not incorporate personal goal-setting options for the players.

Table summarizes the available nutrition and physical activity games for middle school children.

Summary: In the area of nutrition education, serious health games like “Squires Quest” and “Escape from Diab” focused primarily on increasing fruit and vegetables and physical activity among middle school children. They did not address other eating behaviors like

consumption of sweetened beverages and processed snacks that are high among this age group as suggested by national data. Decrease in intakes of these could effectively reduce consumption of additional calorie intake, thus improving energy balance in this population. In addition, the past studies were unable to identify changes in the psychosocial mediators of behavior change.

Possible reasons could be engaging students in simple individual “role playing” in the game without any “peer involvement”, that is vital to behavior change in children and adolescents at this age. Besides, the motivations fostered in the players were based on personal factors only. Environmental and biological factors that heavily influence individual eating and physical activity behaviors were not addressed appropriately. “Fritter Critter” focused on the dietary

Table 2: Summary of games in nutrition and physical activity for middle-school children

Intervention Title, Author	Study design, Participants	Theory	Intervention	Outcome
“5 A Day” Boy Scout badge Thompson et. al, 2009	Randomized Control Trial (RCT) Boy scouts aged 10-14 yrs, 42 troops, 473 boy scouts	Social Cognitive Theory and Elaboration Likelihood model	Nine-week program involves troop activity and internet game program aimed at increasing consumption of eating fruit, juice and low fat vegetables, using goal-setting, and self-efficacy, and home availability	Intervention group showed a significant 1 serving per day consumption increase in fruit and juice with increase in self-efficacy
Fun Food, and Fitness Program for Girls Thompson et. al, 2008	RCT 8-10 year old African-American girls in Texas. 80 girls	Social Cognitive Theory and Elaboration Likelihood model	Eight week internet based program promoting fruit, juice, vegetable, and water intake adapted from the GEMS program	Significant differences were observed in the intake of fruit, juice, and vegetable consumption and self-efficacy
IMPACT Goran & Reynolds, 2005	RCT Fourth grade, ethnically diverse children from LA, 4 schools, 209 students	Social Cognitive Theory	Eight week multimedia obesity prevention intervention aimed at promoting physical activity through use of an interactive CD_ROM program of 8 animated lessons, four classroom lessons, and four family based assignments	Improvement in BMI/body fat for girls, but not boys. Marginal improvements in self-efficacy, outcome expectation (social), and outcome expectancies
Squire’s Quest Baranowski et al, 2003	RCT Fourth grade ethnically diverse children from Houston TX, 26 schools, 1578 students	Social Cognitive Theory	Ten-session educational multimedia game delivered over five weeks. Aimed at increasing fruit, juice, vegetable (FJV) consumption by increasing preferences, asking behaviors, and preparation skills for FJV	Children in the treatment group increased consumption by 1.0 serving more than the controls
Escape from Diab and Nanoswarm: Escape from Inner Space	RCT Middle school aged children between 10-12 yrs, from ethnic minority	Social Cognitive, Self Determination, Elaboration	Nine sessions of each game (16 total sessions). Intervention aimed at increasing fruit and vegetables intake by 3-5 servings everyday, increase water intake and PA	Children increased their fruit and vegetables intake by 0.67 serving. No improvements in other behavioral outcomes or mediators

Baranowski et. al, 2010	communities (African-American, Hispanic), 133 children	Likelihood model, Behavior Inoculation, and Transportation theory	
Fritter Critters			
Schneider, et. al, 2012	Single- group pre and post test Fifth grade students in one school in MA, 97 students, ethnically diverse	Social Cognitive theory	Five sessions 45 minutes per session played for one week, aimed at improving self-efficacy, maintain energy balance by choosing appropriate food using the USDA guidelines. Improvement in positive attitude and self-efficacy towards eating healthy, increase in nutrition and PA behavioral capability

guidelines. They did not provide options for students to assess their own behaviors or set personal goals for themselves to facilitate behavior change. Table 2 summarizes the games in nutrition and physical activity for middle school students.

In contrast, Creature-101 emphasizes on the complex interactions of biology, personal behavior, and the environment that influences eating, and physical activity. It incorporates “guided goal setting” as a way to help students set personal food and physical activity goals for themselves and also provided opportunities to keep track of their progress. Most importantly, it targets the whole range of important eating and physical activity behaviors related to obesity prevention that others did not target in one single intervention before.

Choice, Control & Change (C3) curriculum as the educational content for Creature-101

The C3 curriculum is an inquiry based nutrition science curriculum* developed by the program in Nutrition at Teachers College, Columbia University for middle school students (Grades 6-8). It was funded by Science Education Partnership Award (SEPA), from the National Center for Research Resources (NCRR), a component of the National Institutes of Health (NIH).

The curriculum consists of five units designed with a guiding question in each unit to help students make healthful food and activity choices, and to create healthful personal food environments (Contento et al., 2007).

Unit 1: "Questioning Our Choices" (Matter of Choice; What we like; Our food environment; Research in the community) introduces the curriculum by asking students to think about what choices they make when they eat and are physically active. Through this unit, they learn that humans biologically prefer foods that are high in fat and sugar, and the rationale about

* Inquiry-based learning is a research-based strategy that actively involves students in the exploration of the content, issues, and questions surrounding a curricular area or concept.

the current food options in fast food places, neighborhood, and school. The unit ends with a project for students to learn about what influences their food and activity choices.

Unit 2: "Bodies in Motion" (Making the case; Inside Calvin; Burning up; Balancing act; and My body) introduces and explores the concepts about the body and energy by asking students to think about how they can get the right amount of energy for their body to function well. Through this unit, students learn about digestion, circulation, and metabolism of nutrients in the cells, and how body cells convert the chemical energy from food into body energy. The concepts of dynamic equilibrium and how to maintain a balance between energy intake and energy expenditure are also introduced to students in this unit. To help students relate personally to the materials, a case study of a boy Calvin with high blood pressure, high blood sugar, and is at risk for type 2 diabetes is introduced. The unit ends with a project for student to create self-portraits that illustrates what they want their bodies to do and to demonstrate their understanding of the body.

Unit 3: "Moving toward Health" (Energy in; Energy out; Selecting food goals; How to add steps) asks students' to examine their own eating and activity behaviors and to make healthful food and activity choices using their personal data. Besides a common goal of 10, 000 steps a day measured with a pedometer, students are asked to work towards a specific C3 food and activity goal (eating more fruits and vegetables, drinking more water, eating fewer packaged snacks, eating less frequently at fast food restaurants, and drinking fewer sweetened beverages) throughout the rest of the curriculum. The unit ends with a project for students for collecting data on the average steps per minute for various activities with their pedometers, so that they can add other activities to increase their physical activity.

Unit 4: "Body Science" (Keeping it pumping; Keeping the flow; Fighting diabetes;

Telling others why to do it) introduces students to the science behind the C3 goals and asks them why healthy food and activity choices are important for their bodies. Through experiments, students learn about how healthy food choices and regular physical activities kept their hearts healthy, and decreased risks of heart disease, type 2 diabetes, strokes, and other diseases. As a unit project students create public service announcements to teach the public about the scientific evidence for the C3 goals.

Unit 5: "Maintaining Competence" (Bringing it all together; Sharing the health) provides students with the behavioral capability and skills, and asks them how they can maintain a healthy lifestyle and become competent eaters and movers. Students revisit the scientific evidence that support the C3 goals and evaluate their progress towards achieving their goals to make healthful food and activity choices. Students also display their projects and share healthy food to celebrate what they accomplished during C3 curriculum.

Creature-101 draws its educational content from the 19 lessons⁷ in the five units of the C3 curriculum. Many lesson activities of the curriculum have been adopted in the game. The lesson activities in the game are either in the form of sideshows, short science videos, mini-games, and/or in the form of interactive dialogues. The game also uses an extensive guided goal setting that is not present in the curriculum. Descriptions of the C3 curriculum activities that were used in Creature-101 will be provided in the next chapter.

⁷ C3 consisted of 24 lessons during its efficacy trial, but it was reduced to 19 lessons for dissemination. The current version of C3 has been used for developing Creature-101.

Chapter-III

METHODS

This study is an outcome evaluation of the “Creature-101” game. It assessed the impact of playing Creature-101 on selected eating and physical activity behaviors among middle-school students in New York City. It also measured changes in nutritional behavioral capability and psychosocial variables that are associated with behavior change. This chapter provides detailed descriptions of the methods that were used in the study. These include the study design, setting and participants, theoretical model, intervention (game) development and implementation, instrument and measures, data collection procedures and the data analysis plan.

Study design

This study used a pre and post, intervention and control (delayed intervention) quasi-experimental design.

The study was conducted in NYC (2011-2012 school year). Six public middle schools (four intervention and two control schools) participated in the study. The schools were matched in pairs based on students’ reading and mathematic scores and percentage of students receiving free and reduced price lunch and race ethnicity.

The primary outcomes of the study were to assess decrease in the consumption of sweetened beverages, processed packaged snacks, and reduced frequency and time spent in recreational screen time activities, and increase in water and fruit and vegetable consumption, and physical activity. The secondary outcomes were to assess changes in behavioral capability (knowledge in nutrition) and the psychosocial mediators of behavior change such as outcome expectation (social and physical), self-efficacy, and autonomous motivation.

The study was approved by TC-IRB (Protocol number: 12-136) and the IRB of the New York City Department of Education. Informed consents were obtained from parents and assents from the students (See consent forms in Appendix-A).

Setting and study participants

Study Participants: Participants were middle-school students in grades 6 and 7 (ages 11-13 yrs) attending public schools in the low-income neighborhoods of New York City (Manhattan and Brooklyn).

Eligibility and exclusion criteria for schools: The middle-schools in the low-income neighborhoods⁸ of Manhattan (District 1-6, N=50), Bronx (District-7-12, N=113, and Brooklyn (District-15, N=17) were considered for the study as they could be reached within one hour (by subway) from Teachers College making it easier for the researchers to implement the program.

Enrollment of schools: Schools were enrolled using data from the *insideschools.org* website. The *insideschools.org* website was preferred over the NYC Department of Education (NYC-DOE) website as the information on this site was easy to use. The accuracy of the data was later confirmed with the NYC-DOE website.

The schools were matched in pairs based on the percentage of students who received free lunch ($\geq 45\%$ of students), reading ($\geq 10\%$ of students at grade level), mathematics scores ($\geq 10\%$ of students at grade level), and race/ethnicity distributions ($\geq 50\%$ as Black and Hispanics combined). When all these criteria were satisfied a list of matched paired schools was generated.

⁸ Low-income schools according to USDA are schools where more than 50% of students receive free or reduced price lunch. Our selection criteria was reduced to 45% to enable more schools to be able to participate in the research.

A list of 40 matched school pairs (n=80) was generated. Then, the Principals or Assistant Principals of these schools were contacted over the telephone and/or by email to see if they were interested in the program and willing to participate in the study. The schools that agreed to participate were enrolled in the study. The first school within a matched pair that was enrolled was assigned as the intervention school and the latter was assigned as the control (delayed intervention) school. When one school within a matched pair refused to participate in the study another close match for that particular school was found from the insideschools.org. The process continued till enough pairs of schools were recruited for the study.

For evaluation, four matched pairs (n=8) of schools who agreed to participate in the study were enrolled. However, two schools assigned to the control condition (who agreed to participate) could not begin the study due to scheduling problems. Thus, the study had four schools in the intervention condition and two schools in the control (delayed intervention) condition. The school demographics are summarized in Table 3.

The main reasons cited by the schools that were contacted and did not participate in this research study were lack of time to fit the program due to intense academic schedules, lack of computers for each student, and poor network connectivity in the schools.

Table 3: Demographics of participating schools

School*	Research condition	% Receiving free lunch	White (%)	Black (%)	Hispanic (%)	Asian (%)	Reading scores at grade level(%)	Math scores at grade level (%)
I-A	Intervention	81	11	16	59	15	34.4	60.3
C-A	Control	74	10	41	39	5	34.9	50.0
I-B	Intervention	89	0	50	49	0	26.9	55.3

C-B	Control	82	1	20	68	2	21.1	46.1
I-C	Intervention	47	18	30	45	6	68.2	88.3
I-D	Intervention	95	1	19	80	0	14.2	48.6

-
- Data from the insideschools.org website (2010-2011)

Enrollment of students: Fifteen (sixth grade) classes in the intervention group and seven (four sixth grade, and three seventh grade) classes in the control group were enrolled in the study. During the recruitment process the schools were informed that all sixth and seventh graders could be included in the study. The eighth graders were excluded as it was felt that the game maybe too simple for them, and also that they had highly intense academic schedules at school. The 6th and 7th grade classes that participated were determined by the Principal and the teachers of the respective schools. Signed consents from students and their parents were collected. (The schools were informed that those students or parents who refused to give consents would be excluded from data collection but could still participate in the program).

Setting: The study was conducted in science or health education classes, or in computer classes as a science enrichment program (science education- 3 schools, health education-1school, computer class as science enrichment-2 schools).

Sample size

Sample size was determined based on data from the C3 evaluation study that suggested that the curriculum was highly effective in reducing consumption of high fat and high sugar foods. The same behaviors were chosen for the basis of sample size calculations for Creature-101. It was estimated that in order to be able to detect a 0.5 per day per week (frequency) average reduction in these behaviors with the game, a sample of 407 students was required to achieve 90% power and a sample size of 304 students to achieve 80% power. Based on previous

research with C3, it was also estimated that complete data from approximately 20 students would be collected from each class with a nonparticipation/dropout rate of 25% of each class. Thus, it was estimated that for this evaluation study 10 intervention and 10 control classes (with approximately 25 students in each class) would be required.

Theoretical framework of Creature-101

Creature-101 used mediators and behavior change procedures from two theories namely Social Cognitive theory (Bandura, 1986) and Self-Determination theory (Deci & Ryan, 2000) in its theoretical framework to explain intervention outcomes. The two theories combined provided constructs that have been successfully used in the past in video game design for children to promote healthful eating and physical activity behaviors (Baranowski et al., 2012) (Table 4).

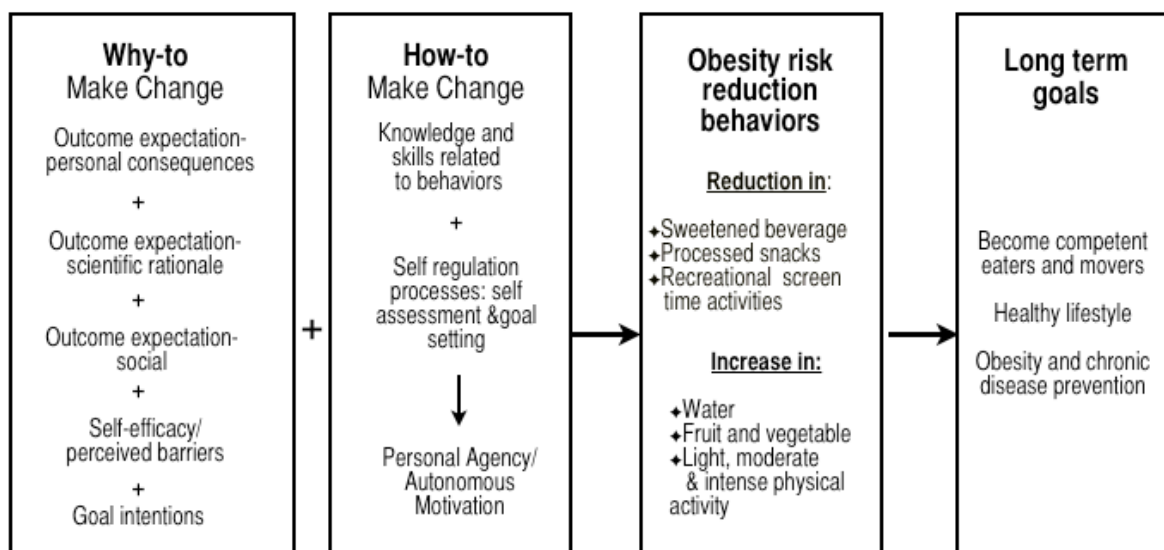
In Creature-101 the students are provided with an “autonomy supportive” environment as they enter into the game world as “saviors of their creatures”. They gradually master the challenges of the creature caretaking processes that instill “competence” and work towards improving the health of their creatures (relatedness). In the game, students’ eating and physical activity behaviors (behavioral factors) were posited to be influenced by outcome expectation that are components of social cognitive factors. Motivation in the game was provided by an engaging age-appropriate storyline, and by providing students with the awareness of the environmental risks and personal consequences of pursuing current behaviors using a scientific rationale and social interactions. The game also helped students’ master behavioral skills by setting personal behavioral goals for taking action for themselves and then following them through. Continual encouragement and reinforcements were provided through additional activities and mini-games, and students’ were rewarded with “badges” to mark their level of mastery in the game. These

factors were expected to lead to self-efficacy beliefs that would enhance personal agency (Table 6).

Table 4: Linking theory and game activities.

Components	SCT	SDT
Story line	X	
Mini games	X	X
Goal Setting	X	X
Goal Monitoring	X	X
Creature caretaking processes	X	X
Mediators		
Outcome expectation (environmental risk perceptions, scientific rationale, and personal consequences)	X	
Self-efficacy	X	
Behavioral capability	X	
Behavioral Skills	X	
Self-regulation through goal setting and monitoring)	X	
Autonomy support		X
Relatedness		X
Competence		X

Figure 2: Theoretical framework of Creature-101



Intervention

Creature-101 was developed by a multidisciplinary team consisting of behavioral scientists in Nutrition from Teachers College Columbia University, and computer and game experts from Stottler Henke Inc., CA. It was funded by a NIH Small Business Innovation Research (SBIR) grant (2009-2012).

Creature-101 used the Choice, Control, and Change (C3) curriculum as its educational content.

Adoption of C3 lesson activities in Creature-101

C3 had 19 lessons. Different lesson activities of C3 were selected and transformed into mini-games, slideshows and educational videos for Creature-101 (Table 5). These activities are as tabulated below. In addition, Creature-101 had its unique storyline with different characters, dialogues and activities that were not a part of C3.

Table 5: Choice, Control & Change activities as the educational content of Creature-101

Unit	Lessons	C3 activities	Creature-101 activities
Unit-1 Investigating Our Choices	Lesson-1: Making the case	Introduction to the module	X
	Lesson-2: As a matter of choice	Discuss food and activity choices	X
	Lesson-3: Investigating a taste for sugar	Investigate taste by taste experiment and record observation	Investigating taste slideshow
	Lesson-4: Investigating what's in food	Visualize French fries, investigating fat and sugar in food	French fries visualization survey, Domino's train game, sugar rush game, fat in chips game
	Lesson-5: Exploring food and activity Environments	Investigating environment, exploring the food system of United states	Exploring the Tween town for food choices, Food system slideshow, food advertizing slideshow
Unit-2 Dynamic Equilibrium	Lesson-6: Exploring Dynamic Equilibrium	Investigating Energy Balance	Energy balance gauge, food and activity behavior bars
	Lesson-7: Digesting food	Human body simulation	Digestion game

	Lesson-8: Burning up	Energy burn, calorimetry experiments	Energy burn and calorimetry videos
	Lesson-9: Creating self-portraits	Creating self-portraits, keeping food logs	X
Unit-3 From Data to health Goals	Lesson-10: Collecting food intake data	Measuring food intake, record personal data	Portion size slideshow, food intake questionnaires
	Lesson-11: Investigating physical activity	Discuss reasons to stay active, keeping track of physical activity, keeping 24 hour activity logs, calibrating pedometers	X
	Lesson-12: Selecting food goals	Using personal data to select food goals	Set food goals through guided goal setting
	Lesson-13: Creating daily activity goals	Use personal data to set activity goals, review of cardiovascular system	X
Unit-4 Effects of our Choices	Lesson-14: keeping it pumping	Review cardiovascular system, discuss cardiovascular fitness, recording heart rate, breathing rate	X
	Lesson-15: Keeping the flow	Compare blood flow, interviewing family for health conditions	Clogging of arteries video
	Lesson-16: Fighting Type-2 diabetes	Investigating blood sugar, discuss risk factors for chronic diseases, exploring family data	Blood sugar video
Unit-5 Maintaining Competence	Lesson-17: Telling others	Sharing information with others, discuss maintaining skills, take actions to make change	X
	Lesson-18: Bringing it all together	Reflections in the 3 journey, recipes for healthy snacks, making personal pledge	Essay on reflections of the game
	Lesson-19: Sharing the Health	Share healthy snacks, display student project on C3	X

Development of the game

Preliminary version of the game

Creature-101 was previously called “LifeSim”. A preliminary version was prototyped as “Nutropolis” using the online gaming platform Metaplace (www.metaplace.com). Metaplace was a virtual world that allowed rapid prototyping and development of online game environments and provided many features central to social games such as chat, instant messaging, extensive reward systems, event stream feeds, and rich graphics. It provided a scripting language that enabled game developers to rapidly develop and test game interactions. Each user was given their own “virtual world” that they could extend by adding objects and functionalities to make the world interesting. Nutropolis was designed to be a world similar to the current food environment of the United States, where sweetened beverages and processed packaged snack foods are abundant and fruits and vegetables are hard to find. In the Nutropolis world, players engaged in activities around caring for a creature they adopted. This served as the focal point for the educational goal of the program, for students to understand through learning scientific evidence, why healthful food choices are important, and to learn practical skills for how to make healthful choices.

Final version of the game

Due to security issues with the Metaplace platform, in Fall 2009 the game migrated to a new game engine called “Open Space” (www.creature101.com), and was renamed “Creature-101”. This engine allowed the game to be hosted within controlled servers so that it provided more security to the students playing the game. The new virtual world was named “Tween” with new avatars, creatures, and different representations of the real world that includes a town, a

farm, a science center, town houses etc. However, OpenSpace did not have social networking features, and since these social features were an important and unique component of Creature-101, OpenSpace was embedded into a social networking structure called Elgg. Through Elgg, students could share accomplishments and goals with others, create groups, and keep tabs of their own progress. Players could create their accounts and log into the Elgg section of the game where they had opportunities to read messages, customize their avatars, build their profiles, add widgets to their homepage, view their activity lists, and freely navigate and explore the Tween world.

Game storyline: The storyline of Creature-101 consisted of a teen inventor named Murphy who accidentally created a wormhole and found himself in a new world that he named “Tween”. Murphy brought the creatures living on Tween sweetened beverages, processed packaged snacks, video games and TV sets from Earth. The creatures soon became addicted to these foods and sedentary activities and became sick. Murphy realized what he had done; and that he had to save the creatures. Thus, he brought with him a few friends from Earth who might be able to help. They included a dietitian (Rodrigo), a food scientist (Angela), and an organic farmer (Claire). Murphy also recruited helpers (players) to adopt creatures to help them regain health. To support this storyline, several dialogues, slideshows, mini-games and activities were created. The game activities helped students learn the scientific evidence about why it was required to make healthful food and activity choices for their creatures and for themselves. They also learned practical skills to set behavioral goals for themselves and follow through with them while they helped their creatures in the game to be healthy.

Behavioral focus of Creature-101

Creature-101 promoted “energy balance” by encouraging the following behaviors:

- a) Increase consumption of water and decrease consumption of sweetened beverages
- b) Increase consumption of fruit and vegetables and decrease consumption of processed packaged snacks
- c) Increase physical activity and decrease screen time and other sedentary activities.

Description of the game

Creature-101 used the game motif of “virtual companion care” in which each student adopted an avatar that depicted himself in the “virtual world” and a creature –a “virtual companion” to take care of and perform various activities and missions within the “virtual world”. The students’ ultimate mission in the game was to achieve the status of a “Master Care Taker”.

As they progressed to become a “Master” in the game, over the course of eight sessions the students learned “why to” make healthful food and activity choices by learning the scientific evidence linking eating and activity to health and energy balance i.e. a focus on outcome expectation or motivations. The game also provided them behavioral skills of “how to” make healthful food and activity decisions for themselves as well as their creatures i.e. focus on self-efficacy and self-regulation skills.

A detailed description of the game is as follows:

Session-1: In the first session, students adopted an avatar to represent themselves in the virtual world, and a creature to take care in this world. They customized their avatars and creatures.

Session-2: In this session students learned about the “creature care-taking” processes that would eventually help them complete different missions within the game to become a “Master Creature Caretaker”. The various activities that provided “motivation” and “skills” were referred

to as the “training processes” in the game. The training process began with students learning that humans are born to like sweet foods. They played a mini-game (sugar rush sort game) to learn about the sugar content in various drinks. They also learned that excess sugar was bad for their bodies by watching a short video (diabetes video).

Session-3: Students learned about fats in this session, why humans loved eating foods that were high in fat, the fat content in various chips (chip sort game), and the consequences of eating large amount of fat in foods (clogging of arteries video). A mini-game (Domino train game) helped them learn that the commonly consumed processed packaged snacks were high in both fat and sugar.

Session-4: In this session students learned about their creature’s energy balance gauge and the three different behavior scales depicted as food, beverage, and physical activity bars. Through these activities students were trained to maintain energy balance in their creatures. In this session, they also learned about how food is produced on earth, and the importance of eating fruits and vegetables (fruit and vegetable puzzle).

Session-5: In this session the students’ made a transition. They were guided to think about *themselves* along with caring for their creatures. Students learned “behavioral skills” about how to estimate their own intakes. They filled brief questionnaires (online within the game) to estimate their own intakes of sweetened drinks, water, processed packaged snacks, fruit and vegetables, and amount of sedentary and physical activity. They also set “behavioral goals” for themselves with the help of guided goal-setting templates.

Session-6: Students in this session learned how food is digested in the body. With two brief science experiment videos (“calorimetry” and “food has energy”) they learned that food has

energy and that energy is released after food is digested. This session also addressed the modern food system that promotes unhealthful food and activity choices.

Session-7: This session focused on the effects of advertizing on our food choices. In addition, it helped students learn how to make healthful eating choices for themselves in the current complex and mostly unhealthful food environment.

Session-8: By the end of this session, students had their creatures in energy balance and attained their “Master Caretaker” status. They also shared their experiences about creature caretaking in “Tween”, and what they learned about “energy balance” in the game with their teachers and friends by writing short descriptions.

The different activities of the game that were played in each session are outlined in Table 6

Table 6: Summary of game activities

Game Sessions	Session activities	Type of activity	Mediators of behavior change
Session-1	Selection of Avatar and a Creature	Activity	Autonomy
	Welcome to Tween	Slideshow	Autonomy
Session-2	Creature caretaking	Slideshow	Autonomy, Competence
	Understanding taste	Slideshow	Behavioral capability
	Sugar rush game	Mini-game	Behavioral capability (knowledge), Outcome expectation (scientific rationale), competence
	Investigating blood sugar	Short video	Outcome expectation (scientific rationale)
Session-3	French fry visualization survey	Brief survey	Outcome expectation (scientific rationale)
	Fat in chips game	Mini-game	Behavioral capability (knowledge), Outcome expectation (scientific rationale), competence, autonomy support (instructions)
	Go with the flow video	Short video	Behavioral capability (knowledge), outcome expectation (scientific rationale)
	Domino snack game	Mini-game	Behavioral capability (knowledge), Outcome expectation (scientific

			rationale), competence, autonomy support (instructions)
Session-4	Creature energy gauge and behavior bars	Slideshow	Behavioral skill, competence
	What's wrong with our food system	Video	Outcome expectation (Environmental risk perception)
	F&V puzzle	Mini-game	Behavioral capability
Session-5	Estimating portion sizes	Slideshow	Behavioral capability, Behavioral skills, competence
	Food and activity frequency questionnaires	Short questionnaire	Behavioral skills, competence
	Goal setting	Short questionnaires	Behavioral skills, self-efficacy, Autonomy, self-regulation
Session-6	Digestion of food	Simulation	Behavioral capability
	Energy burn video	Short video	Behavioral capability
	Calorimetry	Short video	Behavioral capability
	Human food system	Slideshow	Outcome expectation (Environmental risk perception)
Session-7	Do you really believe what that commercial says?	Slideshow	Outcome expectation (Environmental risk perception)
	What's on your plate	Short film	Outcome expectation (Environmental risk perception)
	Maintain creature's energy balance	Activity	Autonomy, competency, behavioral skills.
Session-8	Essay	Activity	Outcome expectation (personal consequences)
	Maintain creature's energy balance	Activity	Autonomy, competency, behavioral skills.

The hypothesis was that Creature-101 would improve students eating behaviors as primary outcomes of the study and psychosocial variables and behavioral capability as secondary outcomes.

Implementation of the intervention

The intervention entailed playing of Creature-101 by students in science, health education, or computer classrooms in the presence of a teacher and a research assistant. The entire study included baseline and post-test surveys and the game that were completed in 9-class sessions.

The pre-test surveys were administered to the students by the research assistant during the first 15 minutes of sessions 1 and 2. The post-test surveys were administered during session 9 and it took the entire session. The game was played in the remaining class time during sessions 1 and 2 and in sessions 3-8 (Table 7). Students played the game at least one day per week for 30 minutes (Table 8).

Professional development of teachers

Teachers at all the schools (both intervention and control) participated in one professional development (PD) session to increase their familiarity with the game. They were explained the purpose of the game and its importance for their students. They played selective parts of the game during the PD sessions to become familiar with the intervention. They also learned to use teacher controls to monitor progress of their students.

In addition, the teachers in the control schools were also explained the activities of “Whyville” (another popular virtual world game played in the control condition in addition to Creature-101) that the students played in the first two sessions in the control condition.

Control (delayed intervention)

The students in the control or delayed intervention group played a popular “virtual world game called “Whyville” in addition to playing Creature-101.

Description of Whyville

Whyville is a popular online “virtual world game” for students between ages 8-15 yrs. Its goal is to engage its users in learning about a broad range of topics, from science and business to art and geography. It was developed by researchers at Caltech and Numedon Inc and has been reported to be one of the most popular virtual worlds with a registered player base of more than 7 million. In Whyville, players can create their own avatars, socialize with others by chatting, hanging out, and cruising around, or play games. Players, who are called Whyvillians, have dozens of different places to visit and opportunities to learn about science in various games and activities (Kafai, 2010). For the purposes of our research we selected 8 mini-games that students played during two half-sessions.

The games are briefly described below:

- a) Recycle: The game objective was to learn about sorting recyclable materials. Students cleaned the Whyville cafeteria by putting each piece of refuse in the correct bins-Plastics, Paper, Glass, and Trash. The game was timed and students earned Whyville currency called clams for each item placed.
- b) Food web game: Students learned about the Coral Reef Food Web. Students had to complete 15 mini food web games on Whyreef in three levels: easy, medium, hard by dragging images of the organisms into boxes to show who ate whom.
- c) Reef station: Students learned about coral reef ecosystems. The game was about identifying the organisms that made up the coral reef of Whyreef. It consisted of plants, fish, invertebrates, mammals and reptiles. They dived into the North or South reef and counted the different species of organisms.

- d) Green Build: Students learned about energy efficient housing. They designed energy efficient houses. To design a house, they clicked on each part of the house and configured it. For example, clicked on the roof and then selected the roof material. They did the same for every part of the house and all the appliances. A summary tab showed them how each item contributed to the overall cost.
- e) Scion Driving School: Scion Driving School taught the basics of real-world driving in Whyville. Each level of the game increased in difficulty as new driving rules were added. If students had driven there safely, the next level was unlocked. If they accidentally did something wrong, the instructor let them know.
- f) Peak Power: This game put students in control of the power plants attached to a city. The students' job was to make sure the city had all the power it needed, in the right mix of power plants to achieve the goals. Students turned the power plants on and off at the right times to meet the electricity needs of the city using 6 different types of power plants available, each with different power generating abilities: coal, hydroelectric, natural gas, nuclear, solar and wind. There were various levels of game play.
- g) Food Sort: In the Whyville cafeteria kitchen food was stored in three general areas: the Freezer, the Refrigerator, and the Dry Goods Rack. Students' sorted and stored food in the proper racks.
- h) Alas Solitaire: In this game students learned about the scientific process to cure diseases. In this card matching game students had to match three cards to make up a set: **Impact** (the impact of a disease), **Experiment** (an experiment to run to try and cure that disease), and **Vehicle** (which testing ground might be used for that particular experiment, depending on its step in the scientific process).

Implementation in the control group

The students in the control group were in the study for 6 sessions. In sessions 1 and 2 they completed the two pre-test surveys and played Whyville. In session 3 they completed one post-test survey and logged into Creature-101 and created their profiles. In session-4 they completed the second post-test survey and played Creature-101. In sessions 5 and 6 they played Creature-101 (Table 7). Then the students had to stop playing the game in class (irrespective of where they were in the game) and were asked to complete the game either at home or on the school computer during free time. Ideally, it was expected that the students in the control group would be the study for the same amount of time as the intervention group (i.e for 9 sessions) and play Whyville for 4 sessions, but the control schools refused to have students play Whyville for 4 sessions as they considered it to be a waste of instructional time.

Table 7: Summary of session activities under each research condition

Sessions	Activities in the Intervention group	Activities in the control group
1.	Pre-test survey-1+Creature-101	Pre-test survey-1+ Whyville
2.	Pre-test survey-2 +Creature-101	Pre-test survey-2 +Whyville
3.	Creature-101	Post-test Survey-1 + Creature-101
4.	Creature-101	Post-test Survey-2+ Creature-101
5.	Creature-101	Creature-101
6.	Creature-101	Creature-101
7.	Creature-101	X
8.	Creature-101	X
9.	Post-test Survey-1, Post-test Survey-2	X

Table 8: Game implementation schedule in the schools

Schools	No. of days played per week	No. of sessions played	Class-Time (minutes each)
Intervention			
I-A	1	9	30
I-B	2	9	30
I-C	4	8	40

I-D	1	9	30
Control			
C-A	2	6	30
C-B	1	6	30

Measures and data collection

Two online self-reported surveys were used for measuring study outcomes. Survey-1 (Eat-n-Play: What You Do) measured students eating and physical activity behaviors and demographic information, and Survey-2 (Eat-n-Play: What You Think) measured behavioral capability (knowledge in nutrition) and psychosocial mediators (outcome expectation-social and physical, self-efficacy, and autonomous motivation) of behavior change. Both surveys were administered to the students online through “Survey Monkey”. Baseline pre-test surveys were administered in the 1st and 2nd sessions and the post-test surveys in the last session of the study. Data were imported into an Excel spreadsheet directly from the survey monkey website.

Instruments and measures

Eat-n-Play: What You Do

It is a 47-item online behavior survey with multiple-choice responses. The purpose of this instrument was to assess students’ usual intakes of sweetened beverages, water, fruit and vegetables, processed packaged snacks and information about their sedentary and physical activities (see Appendix-B for the Eat-n-Play: What You Do instrument). It was modified from the 19-item Beverage and Snack Questionnaire (BSQ) that reported good validity and reliability (Neuhouser, Lilley, Lund, & Johnson, 2009). The instrument contained text plus colored photographs to improve children’s understanding of the behaviors in question, and facilitate comprehension of text, increase attention and add pleasure to the evaluation process (Townsend,

Sylva, Martin, Metz, & Wooten-Swanson, 2008). Figure 3 is an example of an item from the instrument that measures frequency and amount of regular soda consumption.

Figure 3: Picture of item from Eat-n-Play: What You Do



6. How often do you drink fruit drinks or flavored sweetened teas?

- ☐ more than 2 times per day
- ☐ about once per day
- ☐ about 5-6 times per week
- ☐ about 3-4 times per week
- ☐ about 1-2 times per week
- ☐ never drink this



It measured frequency and amount of sweetened beverages (Items 2 to 13), water (Items 14-19), processed packaged snacks (Items 20-29), and fruit and vegetables (Items 30-33). It measured frequency and time spent in physical activity behaviors such as recreational screen time (such as watching TV and playing video or computer games), and light, moderate and intense physical activities (Items 34-43). It also measured demographic variables (Items 44-47).

All frequency questions had responses on a 6-point Likert scale: never, about 1-2 times per week, 3-4 times per week, 5-6 times per week, about once per day and more than 2 times per day. The response scales were modified from the BSQ by iterative testing of the instrument.

The amount scales varied by beverage and food types and for activities. Amounts of regular soda, fruit and flavored sweetened teas were measured on a 5-point scale: never, less than 12 ounces, about 12 ounces, about 20 ounces, more than 20 ounces. Sports drinks and flavored waters were measured on a 4-point scale: never, less than 20 ounces, about 20 ounces, more than 20 ounces. Amount of water was measured on a 5-point scale: never, less than 8 ounces, about 8 ounces, about 16 ounces, about 20 ounces, more than 20 ounces. Chips, candies and processed

packaged snacks was measured on a 4-point scale: never, small, medium, large. Fruit and vegetables were measured on a 5-point scale: never, less than ½ cup, about ½ cup, about 1 cup, more than 1 cup. Time spent in sedentary activities were measured on a 6-point scale: never, less than 1-hr, between 1-2 hours, between 2-3 hours, between 3-4 hours, more than 4 hours and time spent on physical activities were measured on a different 6-point scale: never, between 0-15 minutes, between 16-30 minutes, between 31-45 minutes, between 46-60 minutes, more than 60 minutes (Table-3.5). Time estimated to complete this survey was 10-15 minutes. Examples of items from the instrument in Table 9.

Eat-n-Play: What You Think

This is a 29-item online mediator survey. This instrument measured selective mediators of behavior change derived from the two psychosocial theories namely SCT (self-efficacy and outcome expectation-social and physical) and SDT (autonomy and competency) that were the basis of the intervention. It also measured behavioral capability of selective behaviors that were targeted by the intervention (see Appendix-C for the Eat-n-Play: What You Think instrument).

The outcome expectation and self-efficacy items were modified from the Tell Me About You survey used previously in the evaluation of C3 (Contento et al., 2010; Contento et al., 2007). The autonomous motivation items were modified from the self-determination theory Intrinsic Motivation Inventory (Deci, Eghrari, Patrick, & Leone, 1994), Self-Regulation Questionnaires (Levesque et al., 2007) and the Perceived Competence Scales (Williams, 1998). The items on behavioral capability and outcome expectation (social) were developed for the evaluation.

Behavioral capability items (Items-2, 3, 4) assessed students' knowledge in nutrition of selective eating and physical activity behaviors that were addressed in the intervention. There

were 11 items with multiple response options on the survey. Students had to pick one correct answer.

Outcome expectation (social) (Items-6a-f) measured students' perceptions of their eating and physical activity behaviors when they were in social groups (friends) and were measured on a 4-point scale: never or almost never, sometimes, often, always or almost always.

Outcome expectation (positive and negative physical outcomes of a behavior) (Items-7, 10, 13, 16, 20, 23) were measured separately for each of the targeted behaviors namely sweetened beverages, water, processed packaged snacks, fruit and vegetables, sedentary and physical activities using a 4-point Likert scale: strongly disagree, disagree, agree, strongly agree.

Self-efficacy (situational) (Items-9, 12, 15, 19, 22, 25) were also measured separately for each behavior using a 4-point scale: not sure, a little sure, somewhat sure, very sure. Self-efficacy (amount) was measured by a single item for each behavior (Items-22, 31, 42, 52, 53, 62, 71).

Autonomous motivation and competency were measured for healthy eating (Items-26, 27) and physical activity (Items-28, 29) on a 5-point scale: not true at all, a little true, somewhat true, mostly true, very true. Examples of items are shown in Table 10.

Table 9: Description of Eat-n-Play: What You Do (example of items)

Behaviors	Measures	Items	Sample Questions	Response Scales
Sweetened beverages	Frequency of intake	2, 4, 6, 8, 10, 12	How often do you drink regular sodas?	1) More than 2 times per day
				2) About once per day
				3) About 5-6 times per week
				4) About 3-4 times per week
				5) About 1-2 times per week
				6) Never drink this
	Amount of intake	3, 5, 7, 9, 11, 13	When you drink regular sodas, how much do you usually drink each time?	1) More than 20 ounces
				2) About 20 ounces
				3) About 12 ounces
				4) Less than 12 ounces
				5) Never drink this
Water	Frequency of intake	15, 17	How often do you drink bottled water?	
	Amount of intake	16, 18	When you drink bottled water, how much do you drink at each time?	1) More than 20 ounces
				2) About 20 ounces
				3) About 16 ounces
				4) About 8 ounces
				5) Less than 8 ounces
				6) Never drink this
	Sources	14, 19	How often do you carry refillable water bottles?	1) About everyday
				2) Few times a week
				3) Once a week

Processed packaged snacks	Frequency of intake	20, 22, 24, 26, 28	How often do you eat regular potato chips, tortilla chips, corn chips or other salty snacks?	4) Never carry water bottles
	Amount of intake	21, 23, 25, 27, 29	When you eat regular chips or salty snacks, how much do you eat at each time?	1) About 40 chips (1 large bag) 2) About 25 chips (1 medium bag) 3) About 12 chips (1 small bag) 4) Never eat this
Fruit and vegetables	Frequency of intake	30, 32,	How often do you eat vegetables?	
	Amount of intake	31, 33	When you eat vegetables how much do you eat at each time?	1) More than 1 cup 2) About 1 cup 3) About ½ cup 4) Less than ½ cup 5) Never eat vegetables
Sedentary Activities	Frequency	34, 36	How often do you do sit and watch TV?	1) More than 2 times a day 2) About once per day 3) About 5-6 times per week 4) About 3-4 times per week 5) About 1-2 times per week 6) Never watch TV

Time	35, 37	When you sit and watch TV, for how many hours do you watch it each time?	1) More than 4 hours 2) Between 3-4 hours 3) Between 2-3 hours 4) Between 1-2 hours 5) Less than 1 hour 5) Never watch TV
Physical Activities			
Frequency of intake	38, 40, 42	How often do you do moderate activities?	
Time	39, 41, 43	When you do moderate activities, for how many minutes do you usually do them each time?	1) more than 60 minutes 2) between 46-60 minutes 3) between 31-45 minutes 4) between 16-30 minutes 5) between 0-15 minutes 6) never do these activities
Demographics			
	44, 45, 46, 47	How old are you?	1) 10 yrs or younger 2) 11 yrs 3) 12 yrs 4) 13 yrs 5) more than 13 yrs

Table 10: Description of Eat-n-Play: What You Think (examples of items).

Mediating variables	Items	Sample questions	Response options
Behavioral capability	2(1,2,3); 3(1,2,3); 4(1,2); 5(1,2,3)	How many glasses of water is it recommended to drink in a day?	4 glasses 6 glasses 8 glasses 10 glasses
Outcome expectation-social	6-1(a,b,c,d,e,f)	When I am with my friends we eat fruits and vegetables	Never or almost never Sometimes Often Always or almost always
Outcome expectation-physical	7-1(a,b,c,d); 10-1(a,b,c,d); 13-1(a,b,c,d); 16-1(a,b,c,d); 20-1(a,b,c,d); 23-1(a,b,c,d)	I believe that if I drink lots of sweetened drinks I will get more calories than my body needs	Strongly disagree Disagree Agree Strongly agree
Self-efficacy	8; 9-1(a,b,c,d); 11; 12-1(a,b,c,d,e,f); 14; 15-1(a,b,c,d,e); 17; 18; 19-1(a,b,c,d); 21; 22-1(a,b,c,d); 24; 25-1(a,b,c,d)	I am sure I can drink at least ____ water a day	A few sips 2 glasses 5 glasses 8 glasses I am not sure if I can drink water everyday
Autonomous motivation	26-1(a,b,c,d,e,f,g,h,i); 27-1(a,b,c); 28-1(a,b,c,d,e,f,g,h,i); 29-1(a,b,c)	The reason I would eat healthy is because I want others to see that I can do it	Not true at all A little true Somewhat true Mostly true Very true

Data analysis

Data were directly imported from the survey monkey website as an Excel spreadsheet.

It was analyzed with SPSS version 19.

Demographics of study sample: Descriptive statistics such as means, standard deviations and percentages were used to describe the demographics of the sample. Chi-square

tests were performed to assess differences between the demographics of the intervention and control groups.

Baseline comparisons of groups: Means, standard deviations, and independent t-tests were used for baseline comparisons of the targeted eating and physical activity behaviors, behavioral capability and the psychosocial mediators of behavior change.

Baseline comparisons were also done stratifying by age, gender, and being Hispanic. Chi-square analyses were performed to assess the differences.

All comparisons significant at $p \leq 0.1$ were considered as covariates.

I. Primary data analysis (analysis of research questions)

Research Question-1: What was the impact of the game on eating behaviors in the intervention group as compared to the control group?

- a. Did the students in the intervention group report consuming fewer
 - i) sweetened beverages?
 - ii) processed packaged snacks?
- b. Did the students in the intervention group report consuming more
 - i) water?
 - ii) fruits and vegetables?

Analysis: Responses from students who completed both pre and post test surveys were considered for analysis. All items were coded such that higher scores indicated more consumption. There were 6 items that measured frequencies and 6 items that measured amounts of consumption of popular sweetened beverages. 4 items were deleted (frequency and amounts for diet soda and seltzer water) due to very low baseline means (<1).

Mean scores were calculated for sweetened beverages (SB) and water items. SB included regular sodas, sweetened fruit drinks/iced teas, sports drinks, and flavored water. Bottle and tap water were calculated as a single variable (water).

Posttest means of the intervention and control groups were compared by using the Analysis of Covariance (ANCOVA) model with the pretest means as covariates. Other covariates were determined and added to the model after the analysis of baseline data. The outcome variables were used as dependent variables and the groups (intervention and control) were used as fixed factors. For hypothesis testing significance level was set at $p < 0.05$, and p values $\leq .10$ were suggestive of a trend in the hypothesized direction (Baranowski, 2003).

Research Question-2: What was the impact of the game on physical activity behaviors in the intervention group as compared to the control group?

- a. Did the students in the intervention group report decreased recreational screen time?
- b. Did the students in the intervention group report increased physical activity?

Mean scores were calculated for recreational screen time that included watching TV and playing video games. Mean scores for physical activity included light, moderate and intense activities. Analysis of covariance was performed and interpreted as mentioned above.

Research question-3: What was the impact of the game on the mediating variables in the intervention group as compared to the control group?

Did the students in the intervention group show increase in

- i. Behavioral capability?
- ii. Self-efficacy?
- iii. Outcome expectation (social and physical)?

iv. Autonomous motivation?

Analysis:

Behavioral capability: The behavioral capability items (11-items) on the survey were coded as (0,1) such that 0=incorrect response and 1=correct response. A composite behavioral capability score was calculated for each student for both pre and post-tests. Scores ranged from 0-11(McCaughtry, Fahlman, Martin, & Shen, 2011). Analysis of covariance was performed and interpreted as above.

Outcome expectation (social): All 6-items were coded such that higher scores indicated options that were more desirable. A composite score was calculated for each student for both pre and post-tests. Scores ranged from 6-24. Analysis of covariance was performed and interpreted as above.

Self-efficacy, outcome expectation (physical), autonomous motivation: All items were coded such that higher scores indicated options that were more desirable. Posttest means of the intervention and control groups were compared by using the Analysis of Covariance (ANCOVA) model as described previously. Covariates were determined by baseline data.

II. Additional data analysis

Game dose-response effects on behavioral and psychosocial outcomes: The purpose of this analysis was to examine the evidence for a dose-response relation of playing Creature-101 with behavioral and psychosocial outcomes.

The different activities in the game were rank ordered. A rank in the game represented a game activity. Students had to complete a set of activities (ranks) to make progress in the game. Activities ranged from 1-63 (Level-1-4).

Activities 1-9 (Level-1) indicated that the student signed into the game, created their avatars and creatures and learned about the purpose of the game.

Activities 10-32 (Level-2) indicated that the students had learnt why sugar and fat foods were bad, the sugar contents in variety of sweetened drinks, fat content of chips and the sugar and fat content of processed packaged snacks. They also learnt about the benefits of drinking water, eating fruit and vegetables, and doing physical activity.

Activities 33-51 (Level-3) indicated that the students had analyzed their own eating and physical activity behaviors and had set personal goals for themselves.

Activities 52-63 (Level-4) indicated that students attained energy balance of their creatures and had completed the game by writing their essays about what they learnt in the game (See Appendix-D for the complete list of game activities).

Analysis: Descriptive statistics (percentages) were used to describe the level of game play in the intervention group.

A multiple regression was conducted with the game activities as the independent variable and behavioral and psychosocial outcomes as dependent variables with pretest scores as covariates. Other covariates were added as described before.

Behavioral and psychosocial outcomes among students in school I-C: The purpose of this analysis was to examine the behavioral and psychosocial outcomes among students in the intervention school I-C where the program was delivered as planned. Students reading and math scores were higher in this school as compared to other schools in the intervention condition. Hence, it may be assumed that these students understood the interactive game dialogues better. There were fewer problems with game implementation such as loss of

frequent Internet connectivity, freezing of game browser etc. The students in this school had almost no behavioral problems.

A paired t-test was conducted to assess changes from pre to post test in this subset of students.

Behavioral and psychosocial outcomes among students in intervention school I-C versus other intervention schools: The purpose of this analysis was to examine if the behavioral and psychosocial outcomes among students in the intervention school I-C were better compared to the other intervention schools due to higher academic capability of students and better implementation. Analysis of covariance compared post-test means between the groups.

Behavioral and psychosocial outcomes among students in intervention school I-C versus the control schools. The purpose of this analysis was to establish if the study outcomes were different if the game was implemented with maximum fidelity. Analysis of covariance compared post-test means between the groups (Intervention school-C and all control schools).

Table 11 summarizes the data analysis plan for the evaluation of Creature-101

Table 11: Summary of study data and analysis plan

Research Questions	Measures	Data Analysis
Primary Data Analysis		
Q1.a.i. Did the intervention group report consuming fewer sweetened beverages?	Eat-n-Play: What you do Items: 1,2,5,6	<i>Between group differences:</i> ANCOVA with pretest scores as covariates. Other covariates determined by baseline data.
Q1.a.ii. Did the intervention group report consuming fewer processed packaged snacks?	Eat-n-Play: What you do Items: 19,20, 23, 24, 25, 26	Same as above
Q1.b.i. Did the intervention group report consuming more water?	Eat-n-Play: What you do Items: 14, 15, 16,17	Same as above
Q1.b.ii. Did the intervention group report consuming more fruit and vegetables?	Eat-n-Play: What you do Items: 29,30, 31,32	Same as above
Q2a. Did the students in the intervention group report decreased recreational screen time?	Eat-n-Play: What you do Items: 33, 34, 35, 36	Same as above
Q2b. Did the students in the intervention group report increased physical activity?	Eat-n-Play: What you do Items: 37, 38, 39, 40, 41, 42	Same as above
Q3.i. Did the students in the intervention group show increase in behavioral capability?	“Eat-n-Play: What You Think” Items: 2(1,2,3); 3(1,2,3); 4(1,2); 5(1,2,3)	Same as above
Q3.ii. Did the students in the intervention group show increase in outcome expectation (social)?	“Eat-n-Play: What You Think” Items: 6-1(a,b,c,d,e,f) “Eat-n-Play: What You Think” Items: 8; 9-1(a,b,c,d); 11; 12-1(a,b,c,d,e,f); 14; 15-1(a,b,c,d,e); 17;18; 19-1(a,b,c,d); 21; 22-1(a,b,c,d); 24; 25-1(a,b,c,d)	Same as above <i>Between group differences:</i> ANCOVA with pretest and age as covariates <i>Within group differences:</i> Repeated measures ANOVA
Q3.iii. Did the students in the intervention group show increase in self-efficacy?		

Q3. iv. Did the students in the intervention group show increase in outcome expectation?

“Eat-n-Play: What You Think”
Items: 7-1(a,b,c,d); 10-1(a,b,c,d); 13-1(a,b,c,d); 16-1(a,b,c,d); 20-1(a,b,c,d); 23-1(a,b,c,d)

Same as above

Q3. v. Did the students in the intervention group show increase in autonomous motivations?

“Eat-n-Play: What youthink”
Items: 26-1(a,b,c,d,e,f,g,h,i); 27-1(a,b,c); 28-1(a,b,c,d,e,f,g,h,i); 29-1(a,b,c)

Additional Data Analysis

Was there any game dose-response relationship with the behavioral and psychosocial outcomes?

Eat-n-Play: what you do
Eat-n-Play: What You Think

Multiple regression

Did students in school I-C show improvements in their behaviors and psychosocial mediators from pre to post test?

Eat-n-Play: what you do
Eat-n-Play: What You Think

T-test comparing pre and post test means

Did students in intervention school I-C have better behavioral and psychosocial outcomes when compared with the students in other intervention school?

Same as above

ANCOVA with pretest scores as covariates.

Did the study outcomes different if the game was implemented with maximum fidelity?

Same as above

Same as above

Validation of instruments

The instruments were tested for validity and reliability.

Eat-n-Play: What You Do

Validity: Two types of validity evidence were established.

1a) Criterion validity: The purpose of criterion validity was to assess evidence of how strongly the instrument in question related with another validated measure intended to measure the same or similar outcomes when both were administered at the same time.

Method: The Beverage and Snack questionnaire (BSQ) (Neuhouser et al., 2009) was used to assess concurrent validity of the *frequency* items in Eat-n-Play: What You Do.

Criterion validity of the *amount* items on Eat-n-Play: What You Do were assessed by a single day modified 24-hour recall (Thiagarajah et al., 2008).

Criterion validity for the physical activity items were assessed by a single previous day physical activity recall (PDR) (Pate, Ward, McGraw, & Trost, 1999).

One class of sixth graders from a school in Harlem whose demographics closely matched with the schools in the main evaluation study was selected to conduct validation of instruments. Twenty-five students from this school participated in the validation study and were administered Eat-n-Play: What You Do, BSQ, a single day modified 24 hour food recall and a PDR. Eat-n-Play: What You Do and BSQ were administered in the same session. The modified 24-hour food recall was conducted by the researchers in the next session along with PDR. A modified version of the 24 hour food recall was used where the students were asked to recall specifically about the food items from the previous day that were assessed on the

Eat-n-Play: What You Do survey. The PDR questionnaire was completed independently by the students.

The “frequency of intake” items were correlated with BSQ and the “amount of intake” items were correlated with the modified 24-hour food recall. Time spent on physical activity items were correlated with the PDR questionnaire.

Analysis: BSQ measured behaviors on a 7-point scale (never or less than 1 per week, 1 per week, 2-4 per week, 5-6 per week, 1 per day, 2-3 per day and 4+ per day) whereas Eat-n-Play: What You Do has a 6-point scale (never, about 1-2 times per week, 3-4 times per week, 5-6 times per week, about once per day and more than 2 times per day). The scales were combined to produce a common 5-point scale (never, 1-4 per week, 5-6 times per week, about once per day and more than 2 times per day) for analysis. Spearman Rho correlation coefficients were calculated. The correlations were interpreted as follows: $r < 0.000$ =poor, $0.00-0.21$ =slight, $0.21-0.40$ =fair, $0.41-0.60$ =moderate, $0.61-0.80$ =substantial, $0.81-1.00$ =almost perfect (Landis & Koch, 1977; Nelson, 2009).

For “amount” items the total amount of snacks (drinks) consumed over the day as coded from the modified 24 hour recall was divided by the number of times it was consumed over the day. This provided the amount of snacks (drink) consumed at each time. It was then coded the same way as in Eat-n-Play: What You Do. Spearman correlations were calculated.

For “time spent” on physical activity items, the amount of time spent for a particular activity was divided by the number of times the activity was done on the same day. This provided an estimate of the time spent on an activity for “each time” the activity was performed.

Results: Correlation coefficients for the BSQ items ranged from 0.2-0.8 with a mean of 0.55 ± 0.25 indicating moderate level of agreement between the items. Six of the nine comparisons were statistically significant ($p < 0.05$) (Table 12).

Table 12: Criterion validity of Eat-n-Play: What you do (correlations with Beverage and Snack Questionnaire)

	BSQ (Spearman rho)	p-value
Regular soda	0.2	0.516
Fruit drinks	0.7	0.002
Sports drinks	0.7	0.006
Flavored water	0.2	0.396
Chips	0.8	0.000
Candies	0.8	0.000
Baked snacks	0.7	0.005
Vegetables	0.3	0.191
Fruits	0.6	0.030

The “amount” items for food and “time spent” on activity items on Eat-n-Play: What You Do were correlated to a single previous day food and physical activity recall (Table 13). Spearman rho statistics for the “amount” items ranged between 0.1-0.4 with a mean of 0.31 ± 0.11 indicating fair agreement (candies and baked snacks being statistically significant). Correlations for the “time spent” on physical activity items ranged from 0.2-0.5 with a mean of 0.3 ± 0.21 (the item on moderate physical activity being significant).

Table 13: Correlations between Eat-n-Play: What you do and single day 24-hour recall for food and physical activity

	Spearman rho	p-value
Sodas and fruit drinks	0.1	ns
Sports drinks and flavored water	0.3	ns
Chips	0.3	ns

Candies	0.4	<0.05
Baked snacks	0.4	<0.05
Fruits	-0.2	ns
Vegetables	0.4	ns
Sedentary activities	0.2	ns
Light activities	0.3	ns
Moderate activities	0.5	<0.05
Intense activities	0.3	ns

Conclusion: These results are comparable with other instruments that measured similar behaviors. The Eat-Walk Survey used for the evaluation of C3 reported criterion validity scores between 0.55-0.88 for the frequency items when compared to the Block Food Frequency questionnaire, and scores of 0.33-0.66 for 2-days 24-hour recall (Contento et al., 2010). The BSQ used a 4-day food record as a criterion and reported scores between 0.63-0.70 for frequency items (Neuhouser et al., 2009). Beverage and Snack Screener by Nelson et. al that used a 3-day, 24-hour recall reported a correlation of 0.19-0.38 for both frequency and amount items on the questionnaire (Nelson, 2009).

1b) Construct validity: This type of validity measured constructs that theoretically should be related to each other; are observed to be related to each other (convergent validity), and measures of constructs that theoretically should not be related to each other are observed to not be related to each other (discriminant validity).

Method: In order to assess the convergent validity of the Eat-n-Play: What You Do, a number of hypotheses based on evidence from literature were generated with regard to the associations between Eat-n-Play: What You Do scores. This method was used by Johnson et. al to assess “convergent validity” of an instrument that measured adolescent food habits (Johnson, Wardle, & Griffith, 2002). Based on literature it was predicted that students who consumed more

sodas would eat less fruit and vegetables and more snacks (Bowman, 2004; Coon, Goldberg, Rogers, & Tucker, 2001). More TV viewing was associated with more consumption of soda, more snacks, and less fruit and vegetables and less physical activity (Skatrud-Mickelson, Adachi-Mejia, & Sutherland, 2011; Swinburn, 2008).

Students pre-test scores were used to measure construct validity (both convergent and discriminant). Pre-test scores of all students (n=532) who had participated in our research (intervention and control groups, and validation study) were analyzed to assess construct validity. Spearman-Rho correlation coefficients were calculated.

Results: Correlations between items on the Eat-n-Play: What You Do instrument showed that students who consumed more soda, consumed less fruit and vegetables, and were more sedentary, and students who were more sedentary consumed less fruit and vegetables and were less physically active. This conformed with the priori hypothesis providing evidence for instrument validity (Table 14)

Table 14: Correlations between theoretically similar and dissimilar items

	Spearman-Rho	P-value
Convergent Validities		
Sodas and processed snacks	0.6	<0.01
Sodas and sedentary activities	0.4	<0.01
Television viewing and snacks	0.4	<0.01
Discriminant validities		
Sodas and fruit and vegetables	0.036	ns
Sedentary and physical activity	0.043	ns

Conclusion: Hence, the Eat-n-Play: What You Do has good construct validity.

Reliability: Two types of reliability evidence were established.

2a) Test-Retest reliability: The purpose of Test-Retest reliability is to assess evidence to whether the results of the assessment remained the same if the assessment was conducted again one or two weeks later.

Method: The Eat-n-Play: What You Do instrument was administered twice to the same sub sample of 25 students at a 7-day interval. Spearman-Rho correlation coefficients were calculated.

Results: The Spearman Rho coefficients for the frequency items on Eat-n-Play: What You Do ranged from 0.5-0.9 with a mean of 0.71 ± 0.15 indicating substantial agreement between the two tests. Spearman rho coefficients for the amount/ time spent on activity items ranged from 0.4-0.8 with a mean of 0.66 ± 0.13 also indicated substantial agreement between the tests. All the nine frequency items and eight of nine amount/time spent test-retest comparisons were statistically significant ($p < 0.05$) (Table 15).

Table 15: Test-retest reliability of Eat-n-Play: What you do

	Spearman-rho coefficients	p-value	Spearman-rho coefficients	p-value
	Frequencies		Amounts/Time spent	
Sweetened beverage (H)	0.6	<0.01	0.8	<0.01
Sweetened beverage (L)	0.9	<0.01	0.8	<0.01
Water	0.5	<0.05	0.6	<0.01
Chips	0.7	<0.01	0.4	ns
Candies	0.6	<0.01	0.7	<0.01
Baked snacks	0.6	<0.01	0.6	<0.01
Fruit and vegetables	0.9	<0.01	0.8	<0.01
Sedentary activities	0.9	<0.01	0.7	<0.01
Physical Activity	0.7	<0.01	0.6	<0.01

Conclusion: The results of test-retest reliability of the Eat-n-Play: What You Do instrument is comparable to similar instruments. The EatWalk Survey used in C3 reported test-

retest scores (7days apart) between 0.3-0.8 with most items being between 0.4-0.6. BSQ reported test-retest scores between 0.73-0.77 (7days apart) and the Beverage and Snack Screener administered 14 days apart reported test-retest scores of most items being above 0.6. Hence, Eat-n-Play: What You Do showed good test retest reliability.

2b) Internal consistency reliability: The purpose of internal consistency reliability is to assess how the various items measuring the different constructs delivered consistent scores.

Method: Students' pre-test scores were used to measure Intraclass correlation coefficients (ICC) to assess internal consistency. Pre-test scores of all students (n=532) who had participated in our research were used to calculate ICC (Cronbach-alpha coefficients).

The correlations were interpreted as follows: $\alpha < 0.5$ =poor, $0.5 \leq \alpha < 0.6$ =low, $0.6 \leq \alpha < 0.8$ =questionable, $0.7 \leq \alpha < 0.8$ =acceptable, $0.8 \leq \alpha < 0.9$ =good, $\alpha \geq 0.9$ =Excellent (Bland & Altman, 1997; Cronbach, 1951). However, research shows that Cronbach- alpha < 0.7 is quite common on a scale with less than 10 items, and is considered acceptable (Wilson, 2008).

Results: Cronbach-alpha for the various items on Eat-n-Play: What You Do ranged from 0.45-0.83, with a mean of 0.69. Water had the lowest correlation of 0.45 (Table 16).

Table 16: Internal consistency of Eat-n-Play: What you do

	No. of items	Cronbach- α coefficients
Sweetened beverages	8	0.703
Water	4	0.445
Snacks	8	0.833
Vegetables	2	0.730
Fruit	2	0.596
Sedentary activities	4	0.730
Physical activities	4	0.782

Conclusion: Eat-n-Play: What You Do had acceptable internal consistency. The scores depend both on the quality of items on the questionnaire and the number of items. For water, which is very difficult to measure, four items on the instrument may not have been sufficient. EatWalk reported ICC scores between 0.70-0.88, and had more items than Eat-n-Play: What You Do.

Eat-n-Play: What You Think

Validity:

3a. Construct validity: was established by factor analysis.

Method: Pre-test scores of all students (n=456) who had participated in the research were used to establish the underlying structure of the items on the Eat-n-Play: What You Think instrument. A principal components factor analysis (PCA) with varimax rotation was performed. Eigenvalues of 1 or better and factor loading criteria of |0.45| or better were considered for all items loading on their respective factors (McCaughtry et al., 2011).

Results: PCA established a single factor for each self-efficacy scale for the behaviors as expected. After rotation 54.85% of variance was accounted for self-efficacy for sweetened beverages, 55.28% for water, 63.58% for processed packaged snacks, 62.59% for fruit and vegetables, 57.68% for recreational screen time/sedentary activities and 60.13% for physical activity respectively. It is expected that the principal components should explain >50-70% of cumulative variance (Ma & Dai, 2011). Hence, the items for self-efficacy seemed to have good construct validity. The factor loadings are summarized in Table 17.

Table 17: Construct validity of Eat-n-Play: What You Think (self-efficacy scales)

Items for self efficacy scales	Factor loadings	% Variance explained
Sweetened beverages		54.85
<i>I am sure I can avoid drinking sweetened drinks:</i>	0.787	
After school		
On weekends even if I didn't drink them throughout the week	0.855	
When I am in a party	0.583	
By replacing a high sugar drink with one that has low sugar	0.709	
Water		55.28
<i>I am sure I can drink water:</i>	0.768	
Instead of sweetened drinks when I am thirsty		
Instead of sweetened drinks when I am at a party	0.665	
Even if my friends are drinking soda	0.711	
At breakfast	0.684	
At lunch	0.828	
At dinner	0.790	
Packaged snacks		63.58
<i>I am sure I can avoid eating packaged snacks:</i>	0.807	
At lunch at school		
After-school	0.877	
On weekends even if I didn't eat them throughout the week	0.841	
When I am at a party	0.757	
By replacing with a fruit or a vegetable	0.693	
Fruit and vegetables		62.59
<i>I am sure I can eat fruit and/or vegetables regularly at:</i>	0.797	
Breakfast		
Lunch at school	0.830	
Snack	0.807	
Dinner	0.728	
Recreational screen time/sedentary activities		57.68
<i>I am sure I can avoid:</i>	0.712	
Watching TV even if my family is watching it		
Playing video games even if my friends play them	0.710	
Doing sedentary (sitting) activities if I am tired	0.809	
Doing sitting activities if I am upset	0.802	

Physical activities	60.13
<i>I am sure I can be physically active:</i>	0.725
By mostly using stairs instead of elevators	
By playing outside with my friends on weekends	0.758
Even if I am tired	0.824
Even if I am upset	0.791

For the outcome expectation scales, two factors were extracted (positive and negative outcome expectation) for each behavior except for sedentary activity (only one factor extracted). The total variance explained by the two factors were 70.18% for sweetened beverages, 69.47% for water, 77.47% for processed packaged snacks, 79.10% for fruit and vegetables, and 84.25% for physical activity. The single factor for sedentary activities explained 55.46% of the variance. The factor loadings for the items are summarized in Table 18.

Table 18: Construct validity of Eat-n-Play: What You Think (outcome-expectation scales)

Items for Outcome expectation scales	Factor loadings		% Cumulative variance	
	I	II	Factor-I	Factor-II
Sweetened beverages			44.32	70.18
<i>I believe that if I drink lots of sweetened drinks I will:</i>	580	-0.560		
Get more calories than my body needs				
Stay hydrated in a good way	-	0.839		
Feel sluggish (not able to do activities such a splay sports or dance)	0.819	-		
Get too heavy	0.827	-		
Water			34.46	69.47
<i>I believe by drinking water, I will:</i>	-	-		
Get more calories than my body needs				
Reduce my chances of getting sick	0.842	-		
Stay hydrated in a good way	-	0.780		
Feel sluggish (not able to do activities such a splay sports or dance)	-	0.774		
Packaged snacks			40.22	77.47
<i>I believe that if I eat lots of packaged snacks I will:</i>	-	0.863		

Get more calories than my body needs		
Reduce my chances of getting sick	-	-0.864
Get too heavy	0.895	
Feel sluggish	0.895	
Fruit and vegetables		53.60 79.10
<i>I believe by eating fruit and vegetables I will:</i>	0.830	-
Reduce my chances of getting sick		
Get too heavy	-	0.992
Feel satisfied	0.873	-
Help my body function better	0.832	-
Sedentary activities		55.46
<i>I believe if I do many sedentary activities I will:</i>	-	
Reduce my chances of getting sick		
Get too heavy	0.867	
Feel sluggish	0.876	
Have less time to play sports	0.817	
Physical activities		47.74 84.25
<i>I believe if I do physical activities regularly I will:</i>	-	0.876
Be in energy balance		
Reduce my chances of getting sick	-	-0.901
Become too heavy	-0.937	
Feel sluggish	0.931	

For Autonomous motivation scales three factors were requested (amotivation, controlled motivation and autonomy), however only two factors could be extracted. The first factor (controlled motivation) accounted for 39.31% of variance for food and 46.80% for physical activity. The second factor (autonomy) accounted for 19.28% for food and 19.30% for physical activity. The factor loadings for the items are summarized in Table 19.

Table 19: Construct validity of Eat-n-Play: What You Think (Autonomous motivation scales)

Items for Autonomous motivation scales	Factor loadings		% Cumulative variance	
	I	II	Factor-I	Factor-II
Food			39.31	58.59
<i>The reason I would eat healthy is because:</i>	0.780	-		
It fits with what I want to do in my life				
I personally believe it is the best thing for my life	0.879	-		
I really don't think about it	-	0.687		
Others would be upset with me if I did not	-	0.749		
It is easier to do what I am told than think about it	-	0.594		
It is an important choice I really want to make	0.867	-		
I would feel bad about myself if I did not eat healthy	-0.577	-		
I want others to see I can do it	-0.507	-		
I don't really know why	-	0.744		
Physical activity			46.80	66.11
<i>The reason I would be physically active is because:</i>	0.865	-		
It fits with what I want to do in my life				
I personally believe it is the best thing for my life	0.899	-		
I really don't think about it	-	0.797		
Others would be upset with me if I did not	-	0.791		
It is easier to do what I am told than think about it	-	0.559		
It is an important choice I really want to make	0.870	-		
I would feel bad about myself if I did not eat healthy	-0.682	-		
I want others to see I can do it	-0.560	-		
I don't really know why	-	0.759		

Conclusion: The scales on the Eat-n-Play: What You Think instrument had good construct validity.

Reliability: Two types of reliability evidence were sought.

4a) Test-retest reliability was measured in the same subset of 25 students who participated in the validation study. The Eat-n-Play: What You Think instrument was

administered twice 7 days apart and the results were correlated. Spearman-Rho coefficients were calculated.

Results: For behavioral capability questions the Spearman rho coefficients ranged from 0.4-0.8 with a mean of 0.5 ± 1.12 (moderate agreement) with nine of eleven items being statistically significant. The agreement for outcome expectation (social) ranged from 0.025-0.7 with a mean of 0.4 ± 0.27 (fair agreement) with three of five items being significant. For outcome expectation agreement between both instrument administrations ranged from 0.2-0.8 with a mean of 0.5 ± 0.25 (moderate agreement, four out of six scales being significant). The range of agreement for self-efficacy ranged from 0.3-0.7 with a mean of 0.5 ± 0.13 (moderate agreement, five out of six scales being significant). Mean agreement for autonomy was 0.6 ± 0.14 and competency 0.5 ± 0.14 indicating moderate agreement for both scales (Table 20).

Table 20: Test-Retest reliability of Eat-n-Play: What You Think

	Pearson correlation	p-value
Behavioral capability		
Q1	0.5	<0.05
Q2	0.6	<0.05
Q3	0.8	<0.05
Q4	0.6	<0.05
Q5	0.6	<0.05
Q6	0.4	ns
Q7	0.4	ns
Q8	0.7	<0.05
Q9	0.5	<0.05
Q10	0.5	<0.05
Q11	0.4	ns
	Spearman rho	p-value
Outcome expectation (social)		
Q12	0.1	ns
Q13	0.4	<0.05

Q14	0.6	<0.05
Q15	0.7	<0.05
Q16	0.025	
Q17	0.5	<0.05
Outcome expectation		
Sweetened beverages	0.7	<0.01
Water	0.8	<0.01
Packaged snacks	0.3	Ns
Fruit and vegetables	0.2	Ns
Sedentary activity	0.8	<0.01
Physical activity	0.5	<0.05
Self-Efficacy		
Sweetened beverages	0.5	<0.05
Water	0.6	<0.01
Packaged snacks	0.6	<0.01
Fruit and vegetables	0.7	<0.01
Sedentary activity	0.3	ns
Physical activity	0.5	<0.05
Autonomous Motivation		
Eating healthy	0.7	<0.01
Physical activity	0.5	<0.01
Competency		
Eating healthy	0.6	<0.01
Physical activity	0.4	ns

Conclusion: The rest-retest reliability of the instrument was moderate.

4b) Internal consistency (IC) reliability was measured to establish consistency between test items that measured the different psychosocial mediators of behavior change.

Method: IC was assessed between items that measured self-efficacy, outcome expectation separately for each behavior and autonomous motivation and competency separately for eating and physical activity. The autonomous motivation scale comprised of

three subscales- amotivation, controlled motivation and autonomous motivation. Hence, IC was assessed between each subscale.

Pre-test scores of all students (n=456) who had participated in the research were used to calculate internal consistency. Cronbach- alpha coefficients were calculated and interpreted as mentioned previously.

Behavioral capability and Social Norm questions were not used to measure IC as the questions were independent and did not form a scale.

Results: Internal consistency (n=456) results showed that most scales on the Eat-n-Play: What You Think instrument were reliable. Cronbach-alpha for the self-efficacy scales were acceptable for all the behaviors and ranged from 0.7-0.9. However, the alpha coefficients for outcome expectation scales were low ranging between 0.2-0.7. The scale for outcome expectation for physical activity yielded a negative alpha coefficient of -2.6 that violated the assumption of reliability the model.

The autonomous motivation scale consisted of three subscales amotivation, controlled motivation and autonomy. Cronbach- alpha for food were 0.6, 0.7 and 0.8 and for physical activity were 0.9, 0.7 and 0.7 respectively. Competence scales had high Cronbach-alpha coefficients of 0.9 for both food and physical activity (Table 21).

Table 21: Internal consistency reliability for Eat-n-Play: What you think

Scales	Cronbach-alpha coefficients	Weak items	Cronbach-alpha if item deleted
Self-efficacy			
Sweetened beverages	0.7	-	-
Water	0.9	-	-
Packaged snacks	0.8	-	-
Fruit and vegetables	0.8	-	-
Sedentary activities	0.7	-	-

Physical activities	0.8	-	-
Outcome expectation			
Sweetened beverages	0.5	Get more calories than my body needs	0.6
Water	0.3	Get more calories than my body needs	0.5
Packaged snacks	0.2	Reduce my chances of getting sick	0.5
Fruit and vegetables	0.6	Become too heavy	0.8
Sedentary activities	0.7	Reduce my chances of getting sick	0.8
Physical activities	-2.6	-	-
Autonomous motivation-Food			
Amotivation	0.6	-	-
Controlled motivation	0.7	-	-
Autonomy	0.8	-	-
Competence	0.9	-	-
Autonomous motivation-Physical activity			
Amotivation	0.9	-	-
Controlled motivation	0.7	-	-
Autonomy	0.7	-	-
Competence	0.9	-	-

Conclusion: The Eat-n-Play: What You Think has acceptable internal consistency.

Table 22: Summary of instrument validation

Validity Evidence	Method	Results	Decision
Eat-n-Play: What You Do			
1a. <i>Concurrent validity</i>	Correlated with BSQ, single day food recall, PDR Correlation of scores with other instruments were calculated. Spearman-rho correlation coefficients in SPSS. Correlations will be interpreted as follows: $r < 0.000$ =poor, $0.00-0.21$ =slight, $0.21-0.40$ =fair, $0.41-0.60$ =moderate, $0.61-0.80$ =substantial, $0.81-1.00$ =almost perfect		
Frequency items with beverage and snack questionnaire “not at school” items		$r = 0.2-0.8$ ($M = 0.55 \pm 0.25$)	Moderate
Amount items with previous day 24 hour recall		$r = 0.1-0.4$ ($M = 0.31 \pm 0.11$)	Fair
Time spent on PA items with previous day PA recall		$r = 0.2-0.5$ ($M = 0.3 \pm 0.11$)	Fair
1b <i>Construct validity</i>	Spearman rho correlation coefficients between similar constructs and dissimilar constructs.		
Convergent with theoretically similar constructs		$r = 0.1-0.6$	Moderate
Divergent with theoretically dissimilar constructs		$r = 0.002-0.3$	
2a. <i>Test-retest reliability</i>	7 days apart		
Frequency items		$r = 0.5-0.9$ ($M = 0.71 \pm 0.15$)	Substantial
Amount items		$r = 0.4-0.88$ ($M = 0.66 \pm 0.13$)	Substantial
2b. <i>Internal consistency reliability</i>	Intraclass correlations between scale items. (Cronbach alpha). The correlations interpreted as		

<p>Frequency items</p> <p>Amount items</p> <p>Eat-n-Play: What You Think</p> <p>3a. <i>Construct validity</i></p>		<p>follows: $\alpha < 0.5$ = poor, $0.5 \leq \alpha < 0.6$ = low, $0.6 \leq \alpha < 0.7$ = acceptable, $0.7 \leq \alpha < 0.8$ = good, > 0.8 = excellent</p>
		<p>$r = 0.5 - 0.8$</p> <p>$r = 0.4 - 0.8$</p>
<p>Self-efficacy items</p>		<p>Single factor, variance explained: sweetened beverages-54.85%, water-packaged snacks-63.58%, fruit and vegetables-62.59%, SA-57.68%, PA-60.13%</p> <p>Good</p>
<p>Outcome expectation items</p>		<p>2 factors, variance explained: sweetened beverages-70.18%, water-packaged snacks-77.47%, fruit and vegetables-79.10%, PA-84.25% (only one factor extracted for SA that explains 55.46% of variance)</p> <p>Good</p>
<p>Autonomous motivation items</p>		<p>2 factors extracted, Variance explained: Food-</p> <p>Good</p>

4a. <i>Test-retest reliability</i>	58.59%, PA-66.15%	
4b. <i>Internal consistency reliability</i>	r=0.4-0.8 (M=0.51±1.12)	Moderate
Self-efficacy items	r=0.7-0.9	Acceptable-Excellent
Outcome expectation items	r=0.2-0.7	Low
Autonomous motivation items	r=0.6-0.8 for food, r=0.7-0.9 for PA	Acceptable-Excellent
Competency	r=0.9 for food and PA	Excellent

Summary of instrument validation

The instruments Eat-n-Play: What You Do and Eat-n-Play: What You Think have “acceptable” validity and reliability (Table 22). However, certain measures in the instruments required special attention while making inferences for Creature-101 evaluation.

Eat-n-Play: What You Do had low reliability scores for water. Given that water is a very difficult behavior to measure, and the instrument having only four questions measuring water intake, it would be difficult to explain the game outcomes for water consumption.

In Eat-n-Play: What You Think internal consistency for outcome expectation scales for all the behaviors measured were poor. Deletion of certain items on the scale indicated slightly higher internal consistency values. However, these items were included in the evaluation study as removing them would disturb the scale of the measured construct. Special caution was taken while making inferences for the outcome expectation scales.

CHAPTER-IV

RESULTS

This chapter summarizes the findings of the outcome evaluation of Creature-101.

School demographics and participation

Creature-101 was implemented in 6 out of 8 schools that were recruited (4-intervention and 2-control schools) for the study. Due to conflict with their academic schedules, two schools in the control group did not begin the study.

There were no baseline differences between the participating schools in terms of school size, percentage of free lunch, race and ethnicity distributions and reading and math scores (Table 23).

Table 23: School demographics

School Demographics*	Intervention (n=4)	Control (n=2)	T	P
	Mean± SD	Mean±SD		
Enrollment	442.75±309.09	429.50±95.45	0.079	.958
Percentage of free lunch	78±21.4	78±5.6	.000	1
Race/ethnicity				
White	7.50±8.5	5.50±6.3	.286	.789
Black	28.75±15.39	30.50±14.84	-.132	.901
Hispanic	58.25±15.6	53.50±20.5	.323	.763
Asian	5.25±7.08	3.50±2.12	.324	.762
Test scores				
Reading	35.92±23.07	28.00±.445	.445	.669
Mathematics	63.12±17.4	48.05±2.75	1.147	.315

* Data based on *insideschools.org* website

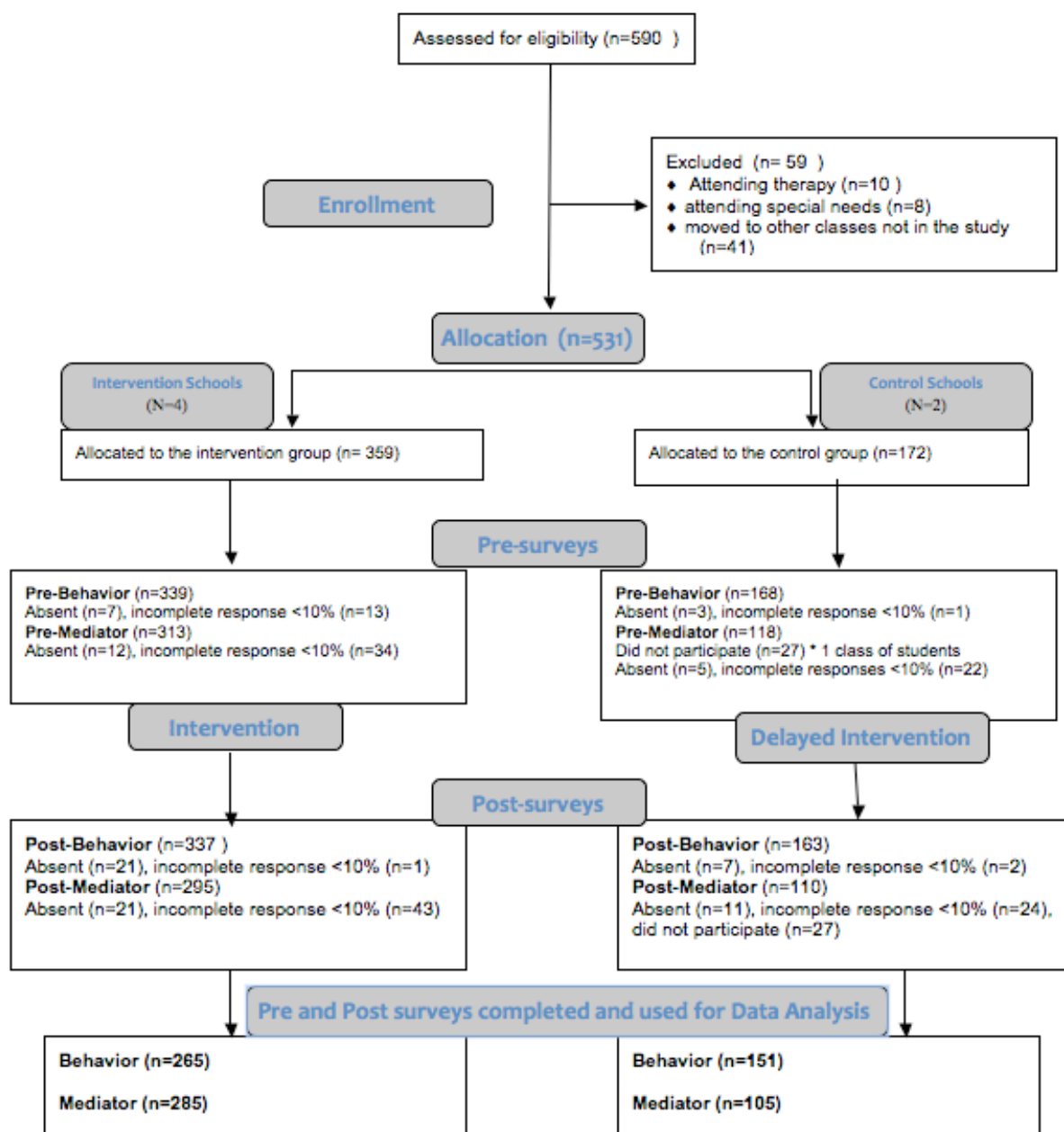
The study enrolled 590 students. 59 students were excluded from the study as they were attending therapy (n=10), and classes for special needs (n=8), or were moved to a different

section that was not participating in the intervention (n=41). Out of 531 students that participated in the study, 359 students were in the intervention and 172 students were in the control group. 339 students in the intervention and 168 students in the control group completed the behavior pre survey (Eat-n-Play: What You Do), and 337 and 163 students completed the behavior post surveys respectively. 313 students in the intervention group and 118 students in the control group completed the mediator pre survey (Eat-n-Play: What You Think), and 295 and 110 students completed the mediator post surveys respectively.

In the intervention group 265 students completed both behavior pre and post surveys and 285 students completed both mediator pre and post surveys. In the control group 151 students completed both behavior pre and post surveys and 105 students completed both mediator pre and post surveys. Data from these students were used for analysis.

A detailed description is provided in Figure-4.

Figure 4: Creature-101 participant flow diagram



Demographics of the study participants

Demographic data were collected on the pre-behavior survey. 50% of the participants were male. Most (83%) were between 11-12 yrs of age (Mean 11.3 ± 0.76 yrs). 65% were Hispanics. Race was inconclusive as 62% of the students reported their race as “others”. Table 24 summarizes the demographic data of all study participants.

Table 24: Demographics of the study participants

Demographics	N	%
Age	509	100
<10 yrs	9	1.8
11 yrs	247	48.5
12 yrs	180	35.4
13 yrs	60	11.8
>13 yrs	13	2.6
Gender	509	100
Male	255	50.1
Female	254	49.9
Hispanic/Latino	501	100
Yes	326	65.1
No	175	34.9
Race	501	100
American Indian or Alaskan Native	14	2.8
Asian	31	6.2
African American	108	21.6
White	33	6.6
Native Hawaiian or other Pacific Islander	4	0.8
Others	311	62.1

At baseline, the intervention and control groups were similar in terms of gender, $\chi^2(df=1, N=509)=0.016$, $p=0.48$ and being Hispanic/Latino, $\chi^2(df=1, N=501)=0.43$, $p=0.290$ but differed significantly in age, $\chi^2(df=4, N=509)=53.43$, $p<0.000$. Students in the control group were older

than the students in the intervention group. The baseline demographics by study groups summarized in Table 25.

Table 25: Demographics of the participants by group (intervention and control)

Demographics	Intervention	Control	χ^2	df	p-value
	N	N			
	345	164			
<10 yrs	7	2			
11 yrs	205	42	53.43	4	0.000
12 yrs	95	85			
13 yrs	31	29			
>13 yrs	7	6			
Gender	342	167			
Male	172	83	0.016	1	0.488
Female	170	84			
Hispanic/Latino	337	164			
Yes	216	110	0.430	1	0.290
No	121	54			
Race	342	159			
American Indian or Alaskan Native	10	4			
Asian	25	6			
African American	59	49	14.890	5	0.011
White	27	6			
Native Hawaiian or other Pacific Islander	3	1			
Others	218	93			

Baseline behavioral and psychosocial characteristics of the groups

Behaviors: At baseline the only significant difference that was noted was in the amount of consumption of processed packaged snacks. The control group consumed significantly more processed packaged snacks ($I=1.72\pm0.66$, $C=1.89\pm0.69$, $p=0.008$) than the intervention group. For the rest of the behaviors the two groups were very similar (Table 26).

Table 26: Baseline Behavioral characteristics of the participants by Group

	Intervention		Control		t	p-value
	N	M±SD	N	M±SD		
Frequency*						
Sweetened beverages	326	2.01±1.09	168	2.03±1.10	-0.259	0.796
Water	325	3.24±1.16	168	3.23±1.24	0.044	0.965
Processed packaged snacks	325	2.29±1.27	167	2.31±1.24	-0.139	0.899
Fruit and vegetables	324	3.05±1.19	166	2.93±1.27	0.955	0.340
Recreational screen time	322	3.22±1.31	164	3.33±1.37	-0.801	0.423
Physical activity	322	2.80±1.28	164	2.73±1.31	0.580	0.562
Amount/Time spent						
Sweetened beverages**	326	1.69±0.85	168	1.76±0.86	-0.871	0.384
Water***	325	3.15±0.97	167	3.22±1.05	-0.712	0.477
Processed packaged snacks****	324	1.72±0.66	167	1.89±0.69	-2.678	0.008
Fruit and vegetables*****	323	2.60±0.92	165	2.60±0.94	0.043	0.965
Recreational screen time^	321	2.95±1.33	164	3.09±1.35	-1.110	0.268
Physical activity^^	319	2.87±1.39	164	2.75±1.26	0.907	0.365

*Frequency Scale: 0-5: (0=never drink this, 1=about 1-2 times per week, 2=about 3-4 times per week, 3=about 5-6 times per week, 4= about once per day, 5=more than 2 times per day.

**Amount Scale (each time): 0-4: (0=never drink this, 1=less than 12 ounces, 2=about 12 ounces, 3=about 20 ounces, 4=more than 20 ounces.

***Amount Scale (each time): 0-4: (0=never drink this, 1=less than 12 ounces, 2=about 12 ounces, 3=about 20 ounces, 4=more than 20 ounces.

**** Amount Scale (each time): 0-3: 0=never eat this, 1=small, 2=medium, 3=large

***** Amount scale (each time):0-4: 0=never eat this, 1=less than half cup, 2=about half cup, 3=about one cup, 4=more than one cup

^ Time spent scale (each time): 0-5: 0=never, 1=less than one hr, 2=between 1-2 hrs, 3=between 2-3hrs, 4=between 3-4 hrs, 5=more than 4 hours.

^^ Time spent (each time):0-5: 0=never, 1=between 0-15 mins, 2=between 16-30 mins, 3=between 31-45 mins, 4=between 46-60 mins, 5=more than 60 mins.

As, noted previously there was a significant difference in students' age between the intervention and control groups. Therefore a chi square analysis was performed to see if age was related to any of the eating or physical activity behaviors between the two groups at baseline. Chi square analysis was also done with the other demographic variables (gender, Hispanic) to rule

out the possibility of these variables to be related with the baseline food and activity behaviors of the students.

When each group was analyzed by demographics (age, gender, and Hispanic) no significant differences were found in the “frequencies” and “amount” of consumption of any of the food behaviors. Significant differences were observed for time spent in physical activities by age ($p=0.025$) gender ($p=0.029$) and being Hispanic ($p=0.028$). The 12 year old, non-Hispanic boys spent more time in physical activities than others (data not shown).

Mediators: At baseline there were significant differences between behavioral capability and social norm scores between the groups (Table 27). The control group had higher behavioral capability ($I=4.18\pm1.47$, $C=4.60\pm1.66$, $p=0.014$) and social norm ($I=16.04\pm2.27$, $C=16.57\pm2.11$, $p=0.029$) scores. However, these differences could not be explained by differences in age, gender or being Hispanic when analyzed by the demographic variables. But since behavioral capability could affect study outcomes, it was added as a covariate in all the statistical models that measured outcomes.

Table 27: Baseline Psychosocial characteristics by Group

	Intervention		Control		t	p-value
	N	M \pm SD	N	M \pm SD		
Behavioral capability[^]	284	4.18 \pm 1.47	112	4.60 \pm 1.67	-2.477	0.014
Social Norms^{^^}	300	16.04 \pm 2.27	114	16.57 \pm 2.10	-2.197	0.029
Outcome expectation*						
Sweetened beverages	318	2.48 \pm 0.64	116	2.56 \pm 0.59	-1.169	0.243
Water	310	2.83 \pm 0.61	113	2.56 \pm 0.59	3.779	0.000
Processed packaged snacks	304	2.57 \pm 2.38	111	2.38 \pm 0.73	2.750	0.008
Fruit and Vegetables	304	2.96 \pm 0.71	110	2.82 \pm 0.73	1.723	(0.086)
Recreational screen time	302	2.28 \pm 0.75	110	2.35 \pm 0.78	-0.828	0.408
Physical activity	300	2.88 \pm 0.70	108	2.48 \pm 0.67	5.277	0.000
Self-efficacy**						
Sweetened beverages	315	2.32 \pm 0.83	115	2.35 \pm 0.85	-0.247	0.805
Water	313	2.52 \pm 0.81	111	2.65 \pm 0.91	-0.954	0.341
Processed packaged snacks	309	2.24 \pm 0.89	113	2.51 \pm 0.97	-1.704	(0.089)
Fruit and Vegetables	306	2.71 \pm 0.90	110	3.02 \pm 0.91	-2.337	0.020
Recreational screen time	302	2.30 \pm 0.75	109	2.35 \pm 0.77	-1.709	(0.088)

Physical activity	302	2.73±0.88	104	2.86±0.93	-1.315	0.189
Autonomous motivation***						
Autonomy-healthy eating	296	3.24±0.73	102	3.28±0.97	-0.334	0.731
Competence-healthy eating	295	3.47±1.21	101	3.74±1.22	-1.885	(0.061)
Autonomy-physical activity	285	3.24±0.77	101	3.33±1.05	-0.705	0.481
Competence-healthy eating	275	3.51±1.27	101	3.81±1.21	-1.206	0.229

^ Behavioral capability scores: 0-11, ^^ social norm scores: 1-16

* Scale: 1-4: 1=not sure, 2=a little sure, 3=somewhat sure, 4=very sure

** Scale: 1-4: 1=not sure, 2=a little sure, 3=somewhat sure, 4=very sure

*** Scale: 1-5: 1=not true at all, 2=a little true, 3=somewhat true, 4=mostly true, 5=very true

Outcome-expectation (physical): The intervention group had significantly higher outcome expectation (p) scores for water ($I=2.83\pm0.61$, $C=2.56\pm0.59$, $p<0.00$), processed packaged snacks ($I=2.57\pm2.38$, $C=2.38\pm0.73$, $p=0.008$), and physical activities ($I=2.88\pm0.70$, $C=2.48\pm0.67$, $p<0.000$), and a trend for eating fruit and vegetables ($I=2.96\pm0.71$, $C=2.82\pm0.73$, $p=0.086$).

When each group was analyzed by demographics it was found that the 11 year old females had higher outcome expectation for drinking water, eating processed packaged snacks and doing physical activities. Hispanics had higher outcome expectation (physical) for drinking water and doing physical activity and being non-Hispanic had higher outcome expectation (physical) for eating fruit and vegetables and processed packaged snacks (data not shown).

Self-efficacy: The control group had higher self-efficacy scores for fruit and vegetables ($I=2.71\pm0.90$, $C=3.02\pm0.91$, $p=0.020$), and a higher trend for eating processed packaged snacks ($I=2.24\pm0.89$, $C=2.51\pm0.97$, $p=0.089$), engaging in recreational screen time activities ($I=2.30\pm0.75$, $C=2.35\pm0.77$, $p=0.088$), and doing physical activities ($I=2.71\pm0.90$, $C=2.90\pm0.93$, $p=0.07$).

When each group was analyzed by demographics it was found that 12yr old, non-Hispanic males had higher self-efficacy for eating fruit and vegetables. The differences in processed

packaged snacks, recreational screen time and physical activity could not be explained by these three demographic variables.

Autonomous motivation: At baseline the control group had higher competence scores for healthy eating ($I=3.47\pm1.21$, $C=3.74\pm1.22$, $p=0.061$). There were no differences between autonomy scores for either healthy eating or physical activity. The differences in competence scores could not be explained by age, gender or being Hispanic. However, it was noted that 13yr old, non-Hispanic females had higher better autonomy scores for healthy eating and 12yr old, non-Hispanic males had better autonomy scores for physical activity.

Covariates for analysis

Based on the above findings, covariates for the univariate models of analysis were determined as follows:

Behaviors: Pretest behavioral capability scores were added as a covariate for all behavior items along with respective pre-test scores as there was a statistically significant difference in behavioral capability scores between the two groups at baseline.

In addition, frequency of processed packaged snacks was adjusted for pre outcome expectation-processed packaged snacks and self-efficacy-processed packaged snack scores, and frequency of physical activity was controlled for physical activity pre outcome expectation.

For the amount items the following covariates were included in addition to pretest and pre behavioral capability scores:

Sweetened beverages: age

Water: pre outcome expectation-water

Processed packaged snacks: pre outcome expectation-processed packaged snacks, pre self-efficacy-processed packaged snacks, gender

Fruit and vegetables: pre outcome expectation-fruit and vegetables, pre self-efficacy-fruit and vegetables

Recreational activities: pre self-efficacy-recreational activities

Physical activity: age, gender, Hispanic, pre outcome expectation-physical activity

Mediators: In addition to respective pretest and pre-behavioral capability scores the following covariates were added.

Behavioral capability: none

Outcome expectation (social): none

Outcome expectation (physical):

Water, processed packaged snacks, fruit and vegetables and physical activity: age, gender, Hispanic

Sweetened beverages, recreational activities: none.

Self-efficacy:

Fruit and vegetables: age, gender, Hispanic

Sweetened beverages, water, processed packaged snacks, recreational activities, physical activity: none

Autonomous motivation:

Autonomy for healthy eating and physical activity: age, gender, Hispanic

Competency for healthy eating and physical activity: none

I. Results of primary analysis

Impact of the game on students' eating behaviors

The primary aim of Creature-101 was to improve students' eating behaviors. It was hypothesized that after playing the game students would decrease their consumption of sweetened beverages and processed packaged snacks, and increase consumption of water and fruit and vegetables.

The data were analyzed two ways: first by the mean of all students who participated in the Creature-101 intervention; and second, by only those who completed the game (i.e. completed Level-4 in the game).

After completion of the intervention that entailed playing Creature-101 for 7 sessions, based on the data for all students in the intervention group there was a significant decrease in the frequency of consumption of processed packaged snacks ($I=1.78\pm1.21$, $C=2.10\pm1.35$, $p\text{-value}<0.000$) when compared to the control group as hypothesized. The effect size of this outcome was small ($\text{partial } \eta^2 = 0.041$) (Ferguson, 2009).

Students in the intervention group also reported that they consumed fewer sweetened beverages ($I=1.72\pm1.12$, $C=1.95\pm1.16$, $p=0.082$), and consumed smaller sizes ($I=1.46\pm0.88$, $C=1.65\pm0.93$, $p=0.098$) of sweetened beverages, and processed packaged snacks ($I=1.49\pm0.65$, $C=1.62\pm0.66$, $p=0.098$). These changes were not significant, but they were positive trends in the hypothesized direction.

However, students did not report any significant changes in their consumption (frequency and amount) of water and fruit and vegetables (Table 28).

Impact of the game on students' physical activity behaviors

It was also hypothesized that by playing Creature-101 students would decrease their recreational screen time behaviors and increase their physical activity in terms of both frequency and time spent on these behaviors. The students in the intervention group did not report significant decrease in the frequency and time spent on recreational screen time activities such as watching TV or playing video games for fun when compared to the control group. However, they did report that their frequency of recreational screen time reduced from about 5-6 times per week to 3-4 times per week. They also did not report any significant increase in the frequency or time spent in physical activities. However, students in the control group reported higher frequency ($I=2.69\pm1.40$, $C=3.01\pm1.30$, $p=0.075$) of doing physical activity. This change was not as hypothesized.

The results are presented in Table 28.

An analysis of data was conducted with game completers to see if the outcomes were different. Game completers were the students who completed the highest level (Level-4) in the game, that is had attained the status of a "Master Creature Caretaker". Based on this analysis for those who completed playing the game ($n=224$), the following results were found: significant decrease in the frequency of sweetened beverages ($I=1.59\pm1.08$, $C=1.95\pm1.16$, $p=0.018$), processed packaged snacks ($I=1.68\pm1.15$, $C=2.1\pm1.35$, $p=0.001$) and amount of sweetened beverage consumption ($I=1.39\pm0.84$, $C=1.65\pm0.93$, $p=0.028$). A positive trend was observed for the decrease in size (amount) of processed packaged snacks ($I=1.46\pm0.65$, $C=1.62\pm0.66$, $p=0.087$) (Table 30).

Table 28: Behavioral outcomes of Creature-101

	Intervention				Control				F	p-value	Partial η^2
	Pretest		Posttest		Pretest		Posttest				
	N	M±SD	N	M±SD	N	M±SD	N	M±SD			
Frequency[*]											
Sweetened beverages	326	2.01±1.09	220	1.72±1.12	168	2.03±1.10	99	1.95±1.16	3.036	(0.082)	0.010
Water	325	3.24±1.16	218	3.09±1.28	168	3.23±1.24	97	2.93±1.42	1.059	0.304	0.003
Processed packaged snacks ¹	325	2.29±1.27	206	1.78±1.21	167	2.31±1.24	91	2.10±1.35	12.866	0.000	0.042
Fruit and vegetables	324	3.05±1.19	216	2.84±1.25	166	2.93±1.27	93	2.65±1.32	0.842	0.359	0.003
Recreational screen time	322	3.22±1.31	214	2.88±1.44	164	3.33±1.37	91	2.95±1.37	1.194	0.275	0.004
Physical activity ²	322	2.80±1.28	201	2.69±1.40	164	2.73±1.31	81	3.01±1.30	3.199	(0.075)	0.011
Amount											
Sweetened beverages ^{3 **}	326	1.69±0.85	214	1.46±0.88	168	1.76±0.86	99	1.65±0.93	2.762	(0.098)	0.009
Water ^{4 ***}	325	3.15±0.97	212	3.04±1.15	167	3.22±1.05	93	3.10±1.25	0.001	0.976	0.000
Processed packaged snacks ^{5 ****}	324	1.72±0.66	205	1.49±0.65	167	1.89±0.69	90	1.62±0.66	2.970	(0.086)	0.010
Fruit and vegetables ^{6 *****}	323	2.60±0.92	204	2.57±0.87	165	2.60±0.94	85	2.5±1.04	1.051	0.306	0.004
Recreational screen time ^{7 ^}	321	2.95±1.33	203	2.66±1.37	164	3.09±1.35	84	2.65±1.31	0.030	0.863	0.000

Physical activity ^{8^^}	319	2.87±1.39	193	2.96±1.42	164	2.75±1.26	81	2.97±1.49	0.253	0.615	0.001
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(P<0.05=significant, p≥0.05<1=trend)

All variables adjusted for respective baseline and behavioral capability scores. In addition, the following were adjusted:

¹ adjusted for outcome expectation (pre) for processed packaged snacks

² adjusted for outcome expectation (pre) and self-efficacy (pre) for physical activity

³ adjusted for age

⁴ adjusted for outcome expectation (pre) for water

⁵ adjusted for outcome expectation (pre), self-efficacy (pre), gender for water

⁶ adjusted for self-efficacy (pre), outcome expectation (pre) for fruit and vegetables

⁷ adjusted for self-efficacy (pre) for recreational screen time

⁸ adjusted for age, gender, Hispanic, outcome expectation (pre) for physical activity

*Frequency Scale: 0-5: (0=never drink this, 1=about 1-2 times per week, 2=about 3-4 times per week, 3=about 5-6 times per week, 4= about once per day, 5=more than 2 times per day.

**Amount Scale (each time): 0-4: (0=never drink this, 1=less than 12 ounces, 2=about 12 ounces, 3=about 20 ounces, 4=more than 20 ounces.

***Amount Scale (each time): 0-4: (0=never drink this, 1=less than 12 ounces, 2=about 12 ounces, 3=about 20 ounces, 4=more than 20 ounces.

**** Amount Scale (each time): 0-3: 0=never eat this, 1=small, 2=medium, 3=large

***** Amount scale (each time):0-4: 0=never eat this, 1=less than half cup, 2=about half cup, 3=about one cup, 4=more than one cup

^ Time spent scale (each time): 0-5: 0=never, 1=less than one hr, 2=between 1-2 hrs, 3=between 2-3hrs, 4=between 3-4 hrs, 5=more than 4 hours.

^^ Time spent (each time):0-5: 0=never, 1=between 0-15 mins, 2=between 16-30 mins, 3=between 31-45 mins, 4=between 46-60 mins, 5=more than 60 mins

Table 29: Psychosocial outcomes of Creature-101

	Intervention				Control				F	P
	Pretest		Posttest		Pretest		Posttest			
	N	M±SD	N	M±SD	N	M±SD	N	M±SD		
Behavioral capability [^]	284	4.18±1.47	245	5.06±0.91	112	4.60±1.67	99	4.06±1.43	06.429	0.012
Outcome expectation-social ^{^^}	300	16.04±2.27	269	16.22±2.09	114	16.57±2.10	100	16.36±1.84	0.099	0.754
Outcome expectation-physical*										
Sweetened beverages	318	2.48±0.64	256	2.56±0.63	116	2.56±0.59	103	2.51±0.76	0.650	0.421
Water ¹	310	2.83±0.61	229	2.52±0.68	113	2.56±0.59	92	2.49±0.70	0.008	0.927
Processed packaged snacks ¹	304	2.57±2.38	226	2.50±0.73	111	2.38±0.73	81	2.75±0.72	0.275	0.601
Fruit and vegetables ¹	304	2.96±0.71	223	2.78±0.68	110	2.82±0.73	81	2.75±0.72	0.275	0.601
Recreational screen time	302	2.28±0.75	238	2.28±0.73	110	2.35±0.78	88	2.46±0.73	2.860	0.092
Physical activity ¹	300	2.88±0.70	218	2.49±0.64	108	2.48±0.67	77	2.55±0.63	0.534	0.466
Self-efficacy (situational)**										
Sweetened beverages	315	2.32±0.83	251	2.38±0.81	115	2.35±0.85	101	2.48±0.85	0.974	0.324
Water	313	2.52±0.81	249	2.67±0.83	111	2.65±0.91	99	2.69±0.94	0.001	0.973
Processed packaged snacks	309	2.24±0.89	244	2.46±0.85	113	2.51±0.97	92	2.59±1.01	0.695	0.405
Fruit and vegetables ¹	306	2.71±0.90	225	2.84±0.88	110	3.02±0.91	82	2.72±1.00	1.231	0.268
Recreational screen time	302	2.30±0.75	239	2.30±0.85	109	2.35±0.77	86	2.36±0.95	0.109	0.741

Physical activity	302	2.73±0.88	234	2.81±0.84	104	2.86±0.93	82	2.72±1.00	1.231	0.268
Self-efficacy (amount)										
Sweetened beverages	314	2.36±1.17	250	2.69±1.18	116	2.35±1.09	101	2.65±1.08	0.000	0.990
Water	314	2.69±1.10	250	2.84±1.05	115	2.76±1.10	97	2.74±1.00	1.028	0.311
Processed packaged snacks	306	2.81±1.27	243	3.01±1.13	113	2.76±1.27	91	3.02±1.01	0.002	0.968
Fruits ¹	309	2.85±1.16	242	2.63±1.10	112	2.98±1.70	89	2.67±1.18	0.060	0.806
Vegetables ¹	301	2.31±1.27	233	2.22±1.19	111	2.34±1.23	88	2.45±1.17	2.160	0.143
Recreational screen time	301	2.40±1.41	239	2.72±1.28	111	2.22±1.39	87	2.59±1.32	0.393	0.531
Physical activity	301	2.42±1.23	236	2.60±1.3	108	2.80±1.19	83	2.65±1.14	0.043	0.836
Autonomous motivation***										
Autonomy-healthy eating ¹	296	3.24±0.73	217	3.25±0.73	102	3.28±0.97	73	3.12±1.06	0.735	0.392
Autonomy-physical activity ¹	295	3.47±1.21	208	3.20±0.73	101	3.74±1.22	71	3.23±1.11	0.139	0.710
Competence-healthy eating	285	3.24±0.77	231	3.42±1.22	101	3.33±1.05	78	3.53±1.32	0.006	0.938
Competence-physical act.	275	3.51±1.27	221	3.63±1.23	101	3.81±1.21	77	3.60±1.22	0.421	0.517

(P<0.05=significant, p≥0.05<1=trend)

All variables adjusted for respective baseline scores. In addition, the following were adjusted:

¹ adjusted for age, gender, Hispanic

[^] Behavioral capability scores: 0-11, ^{^^} outcome expectation (social) scores: 6-24

* Scale: 1-4: 1=not sure, 2=a little sure, 3=somewhat sure, 4=very sure

** Scale: 1-4: 1=not sure, 2=a little sure, 3=somewhat sure, 4=very sure

*** Scale: 1-5: 1=not true at all, 2=a little true, 3=somewhat true, 4=mostly true, 5=very true

Table 30: Outcomes among game completers

	Intervention				Control				P
	Pretest		Posttest		Pretest		Posttest		
	N	M±SD	N	M±SD	N	M±SD	N	M±SD	
Frequency									
Processed snacks	207	2.14±1.23	149	1.68±1.15	167	2.31±1.24	91	2.10±1.35	0.001
Sweetened beverages	208	1.88±1.09	156	1.59±1.08	166	2.03±1.10	99	1.95±1.16	0.018
Amount									
Processed snacks*	206	1.67±0.65	148	1.46±0.65	167	1.89±0.69	90	1.62±0.66	0.087
Sweetened beverages **	208	1.62±0.83	156	1.39±0.84	168	1.76±0.86	99	1.65±0.93	0.028
Mediators									
Behavioral Capability	185	4.24±1.5	169	5.52±4.8	114	4.58±1.66	99	4.06±1.43	0.001

(P<0.05=significant, p≥0.05<1=trend)

All variables adjusted for respective baseline and behavioral capability scores

*Frequency Scale: 0-5: (0=never drink this, 1=about 1-2 times per week, 2=about 3-4 times per week, 3=about 5-6 times per week, 4= about once per day, 5=more than 2 times per day.

*Amount Scale (each time): 0-3: 0=never eat this, 1=small, 2=medium, 3=large

**Amount Scale (each time): 0-4: (0=never drink this, 1=less than 12 ounces, 2=about 12 ounces, 3=about 20 ounces, 4=more than 20 ounces.

Behavioral capability Scale: 0-11

Table 31: Summary of the effectiveness of the Creature-101 game on behavioral and psychosocial outcomes.

Outcomes	Overall Sample	Game Completers
Behavioral Outcomes		
Frequency of intake		
Sweetened beverages	Positive trend	Significant change
Water	-	
Processed packaged snacks	Significant change	Significant change
Fruit and vegetables	-	
Frequency of Activity		
Recreational screen time (TV and video games)	-	
Physical activity	-	
Amount of consumption		
Sweetened beverages	Positive trend	Significant change
Water	-	
Processed packaged snacks	Positive trend	Positive trend
Fruit and vegetables	-	
Time Spent on Activities		
Recreational screen time (TV and video games)	-	
Physical activity	-	
Psychosocial outcomes		
Behavioral capability	Significant change	Significant change
Outcome expectation-social	-	
Outcome expectation-physical	-	
Self-efficacy	-	
Autonomous motivation	-	

Significant changes ($p < 0.05$), (-) = no changes, Positive trend ($p \geq 0.05 < 1 = \text{trend}$)

Impact of the game on students' behavioral capability and psychosocial variables of behavior change

The secondary aim of the study was to improve students' behavioral capability (knowledge) and the psychosocial mediators of behavior change such as outcome expectation (social), outcome expectation, self-efficacy (situational and amount) for the targeted behaviors and autonomous motivation.

After playing the game for 7 sessions students in the intervention group showed significant changes in their behavioral capability scores. On a 11-point scale students in the intervention group increased their mean behavioral capability scores from 4.18 ± 1.47 points at baseline to 5.06 ± 0.91 points post intervention. In the control group the mean behavioral capability scores changed from 4.60 ± 1.67 at baseline to 4.06 ± 1.43 points post intervention. These changes between the groups were significant ($p=0.012$).

However, the students in the intervention group did not report any changes in their outcome expectation (social), outcome expectation, self-efficacy and autonomous motivation (The data were analyzed two ways: first by the mean of all students who participated in C-101; and second, by only those who completed the game.)

The results are presented in Table 29.

II. Results of additional data analysis

Game dose-response effects on behavioral and psychosocial outcomes

The Creature-101 game was played by 359 students in the intervention group. There were 62 activities in the game that had to be completed by the students at four levels. A frequency

analysis showed that 13 students completed Level-1, 57 completed Level-2, 65 completed Level-3, and 224 students completed Level-4 (Table 32).

Table 32: Frequencies of game play

Game Levels	No. of players	Frequency%
1	13	3.6
2	57	15.9
3	65	18.1
4	224	62.4
Total	359	100

In order to examine the evidence for a dose-response relation of playing Creature-101 with behavioral and psychosocial outcomes, a multiple regression analysis was performed. Results from multiple regression indicated that the game significantly predicted the *frequency* ($p=0.007$) and *amount* ($p=0.049$) of sweetened beverage consumption among its players. The R^2 values were 0.203 and 0.248 respectively (medium effect) (Ferguson, 2009). This indicates that 20.3% of variance for frequency and 24.8% for amount of SB consumption were explained by the model. The beta weights are presented in Table 33.

Table 33: Dose response summary for eating and physical activity behaviors

	B	SeB	B	p	Adj. R^2
Frequency					
Sweetened beverages	-0.013	0.005	-0.166	0.007	0.203
Water	0.004	0.006	0.049	0.428	0.165
Processed packaged snacks ¹	-0.004	0.005	-0.045	0.444	0.305
Fruit and vegetables	0.008	0.006	0.092	0.160	0.108
Recreational screen time	0.001	0.006	0.008	0.893	0.248
Physical activity ²	-0.002	0.006	-0.023	0.725	0.209
Amount					
Sweetened beverages ³	-0.008	0.004	-0.120	0.049	0.248
Water ⁴	0.003	0.005	0.031	0.632	0.144
Processed packaged snacks ⁵	0.001	0.003	0.071	0.773	0.314
Fruit and vegetables ⁶	0.007	0.004	0.105	0.127	0.125

Recreational screen time ⁷	0.001	0.006	0.007	0.908	0.311
Physical activity ⁸	0.003	0.006	0.026	0.675	0.309

All variables adjusted for respective pretest and knowledge scores. In addition, the following were further adjusted

¹ adjusted for outcome expectation (pre) for processed packaged snacks

² adjusted for outcome expectation (pre) and self-efficacy (pre) for physical activity

³ adjusted for age

⁴ adjusted for outcome expectation (pre) for water

⁵ adjusted for outcome expectation (pre), self-efficacy (pre), gender for water

⁶ adjusted for self-efficacy (pre), outcome expectation (pre) for fruit and vegetables

⁷ adjusted for self-efficacy (pre) for recreational screen time

⁸ adjusted for age, gender, hispanic, outcome expectation (pre) for physical activity

Multiple regression analysis results also indicated that playing Creature-101 significantly predicted behavioral capability ($p=0.002$) with very small effect (ad. $R^2=0.041$), outcome expectation for eating fruit and vegetables ($p=0.050$, ad. $R^2=0.041$) and doing PA ($p=0.016$, ad. $R^2=0.024$). The beta weights are presented in Table 34.

Table 34: Dose response summary for behavioral capability and psychosocial mediators of behavior change

	B	SeB	B	p	Ad. R²
Behavioral capability	0.053	0.017	0.197	0.002	0.041
Social norms	-0.007	0.009	-0.049	0.420	0.036
Outcome expectation					
Sweetened beverages	0.000	0.003	-0.010	0.871	0.020
Water ¹	0.004	0.003	0.090	0.191	0.003
Processed packaged snacks ¹	-0.003	0.004	-0.056	0.413	0.006
Fruit and vegetables ¹	0.006	0.003	0.135	0.050	0.078
Recreational screen time	0.010	0.032	0.021	0.753	0.017
Physical activity ¹	0.008	0.003	0.172	0.016	0.024
Self-efficacy					
Sweetened beverages	0.026	0.033	0.048	0.427	0.110
Water	-0.002	0.004	-0.032	0.606	0.076
Processed packaged snacks	0.003	0.004	0.043	0.474	0.163
Fruit and vegetables ¹	0.003	0.004	0.047	0.476	0.095
Recreational screen time	0.002	0.004	-0.019	0.774	0.035

Physical activity	0.006	0.004	0.101	0.112	0.089
Autonomous motivation					
Autonomy-healthy eating ¹	0.002	0.003	0.045	0.492	0.171
Autonomy-physical activity ¹	0.003	0.004	0.048	0.464	0.184
Competence-healthy eating	0.000	0.005	-0.006	0.927	0.189
Competence-physical act.	0.15	0.005	0.164	0.006	0.243

All variables adjusted for respective pretest and behavioral capability scores. In addition, the following were further adjusted

¹ adjusted for respective pre-Outcome expectation

Behavioral and psychosocial outcomes among students in school I-C:

Fifty-one students in the intervention school I-C participated in the program and played the game, of which forty-five students completed both pre and post-test behavior surveys. Results of paired t-tests show that the students reported significant decrease in frequency of sweetened beverages ($T1=1.41\pm0.94$, $T2=0.95\pm0.36$, $p=0.002$), processed packaged snacks ($T1=1.77\pm1.14$, $T2=1.25\pm1.04$, $p=0.002$), recreational screen time ($T1=2.87\pm1.35$, $T2=2.55\pm1.55$, $p=0.035$), and amount of sweetened beverage ($T1=1.37\pm0.73$, $T2=0.98\pm0.65$, $p=0.001$), processed packaged snack ($T1=1.61\pm0.75$, $T2=1.28\pm0.68$, $p<0.000$), and time spent in recreational screen time activities ($T1=2.66\pm1.22$, $T2=2.15\pm1.30$, $p=0.003$) (Table 35).

Table 35: Behavioral outcomes among intervention school I-C students.

	Posttest (T2) (n=45)	Pretest (T1) (n=45)	T	P
	M±SD	M±SD		
Frequency				
Sweetened beverages	0.95±0.36	1.41±0.94	3.43	0.002
Water	3.61±1.33	3.43±1.22	0.904	0.371
Processed packaged snacks	1.25±1.04	1.77±1.14	3.212	0.002
Fruit and vegetables	3.33±1.22	3.23±1.33	0.627	0.534
Recreational screen time	2.55±1.55	2.87±1.35	2.172	0.035

Physical activity ²	2.97±1.36	2.99±1.20	0.067	0.947
Amount				
Sweetened beverages	0.98±0.65	1.37±0.73	3.682	0.001
Water	3.04±1.20	3.02±1.03	0.119	0.905
Processed packaged snacks	1.28±0.68	1.01±0.75	3.831	0.000
Fruit and vegetables	2.70±0.90	2.57±0.89	0.960	0.342
Recreational screen time	2.15±1.30	2.66±1.22	3.19	0.003
Physical activity	3.11±1.21	3.02±1.14	0.611	0.544

(P<0.05=significant, p≥0.05<1=trend)

*Frequency Scale: 0-5: (0=never drink this, 1=about 1-2 times per week, 2=about 3-4 times per week, 3=about 5-6 times per week, 4= about once per day, 5=more than 2 times per day.

** Amount Scale (each time): 0-4: (0=never drink this, 1=less than 12 ounces, 2=about 12 ounces, 3=about 20 ounces, 4=more than 20 ounces.

Students showed a marked improvement in their behavioral capability scores (T1=4.77±1.66, T2=10.71±7.18, p<0.000). Students also reported increased outcome expectation for drinking water (T1=2.55±0.34, T2=2.75. p=0.05), and doing physical activity (T1=2.45±0.28, T2=2.81±0.73, p=0.004). In addition, students also reported a positive trend at increasing their autonomy (T1=3.10±0.84, T2=3.32±0.93, p=0.088) and competency (T1=3.82±1.17, T2=3.32±0.93, p=0.056) for eating healthy Table 36.

Table 36: Psychosocial outcomes among intervention school I-C students

	Posttest (T2) (n=45)	Pretest (T1) (n=45)	T	P
	M±SD	M±SD		
Behavioral capability	10.71±7.18	4.77±1.66	4.610	0.000
Outcome expectation-social	16.85±2.57	16.77±1.88	0.134	0.894
Outcome expectation				
Sweetened beverages	2.53±0.55	2.60±0.53	0.665	0.510
Water	2.75±0.62	2.55±0.34	2.026	0.050
Processed packaged snacks	2.69±0.69	2.62±0.41	0.512	0.611
Fruit and vegetables	3.00±0.76	2.98±0.44	0.098	0.923
Recreational screen time	2.66±0.68	2.56±0.63	0.610	0.546
Physical activity	2.81±0.73	2.45±0.28	3.102	0.004

Self-Efficacy				
Sweetened beverages	2.71±0.65	2.54±0.76	1.408	0.167
Water	2.89±0.62	2.93±0.83	0.385	0.702
Processed packaged snacks	2.65±0.73	2.62±0.84	0.306	0.762
Fruit and vegetables	3.03±0.78	3.20±0.87	1.052	0.299
Recreational screen time	2.43±0.64	2.33±0.91	0.625	0.536
Physical activity	2.75±0.80	3.00±0.79	1.452	0.156
Autonomous motivation				
Autonomy-healthy eating	3.32±0.93	3.10±0.84	1.754	0.088
Autonomy-physical activity	3.21±0.96	3.20±0.86	0.054	0.957
Competence-healthy eating	3.32±0.93	3.82±1.17	1.976	0.056
Competence-physical act.	4.18±1.06	4.07±1.03	0.805	0.426

Behavioral and psychosocial outcomes among students in school I-C versus other intervention schools:

When the students in school I-C (N=51) were compared to all other intervention school students (N=308), students in school I-C showed significant decrease in the frequency of consumption of sweetened beverages (I-C=0.91±0.84, Other=1.89±1.10, $p<0.000$), processed packaged snacks (I-C=1.19±0.95, Other=1.90±1.22, $p=0.021$), amount of sweetened beverages (I-C=0.94±0.65, Other=1.59±0.89, $p=0.001$), and processed packaged snacks (I-C=1.29±0.65, Other=1.54±0.65). They also showed a positive trend in increasing frequency of water consumption (I-C=3.63±1.38, Other=2.97±1.24, $p=0.059$), and decreasing time spent on recreational screen time activities (I-C=2.24±1.35, Other=2.74±1.35, $p=0.052$). The students also had higher behavioral capability scores (I-C=10.71±7.18, Other=4.10±1.74, $p<0.000$) (Table 37).

Table 37 Outcomes among students in I-C versus other intervention schools

	Other intervention schools				I-C				P
	Pretest		Posttest		Pretest		Posttest		
	N	M±SD	N	M±SD	N	M±SD	N	M±SD	
Frequency									
Processed snacks	274	2.40±1.26	179	1.90±1.22	51	1.75±1.20	39	1.19±0.95	0.021
Sweetened beverages	275	2.11±1.08	179	1.89±1.10	51	1.48±0.97	39	0.91±0.95	0.021
Water	274	3.21±1.15	173	2.97±1.24	51	3.40±1.26	38	3.63±1.38	0.059
Amount									
Processed snacks*	273	1.75±0.64	173	1.54±0.65	51	1.57±0.75	39	1.29±0.65	0.001
Sweetened beverages **	275	1.75±0.86	179	1.59±0.89	51	1.42±0.75	39	1.29±0.65	0.031
Recreational screen time activities***	270	3.02±1.74	163	2.74±1.35	51	2.82±1.32	39	2.24±1.35	0.052
Mediators									
Behavioral Capability	241	4.10±1.74	210	4.04±1.74	51	4.65±1.79	39	10.71±7.18	0.000

(P<0.05=significant, p≥0.05<1=trend)

All variables adjusted for respective baseline and behavioral capability scores

*Frequency Scale: 0-5: (0=never drink this, 1=about 1-2 times per week, 2=about 3-4 times per week, 3=about 5-6 times per week, 4= about once per day, 5=more than 2 times per day.

*Amount Scale (each time): 0-3: 0=never eat this, 1=small, 2=medium, 3=large

**Amount Scale (each time): 0-4: (0=never drink this, 1=less than 12 ounces, 2=about 12 ounces, 3=about 20 ounces, 4=more than 20 ounces.

Time spent Scale (each time):

***^ Time spent scale (each time): 0-5: 0=never, 1=less than one hr, 2=between 1-2 hrs, 3=between 2-3hrs, 4=between 3-4 hrs, 5=more than 4 hours.

Behavioral capability Scale: 0-11

Behavioral and psychosocial outcomes among students in school I-C versus control schools

When students in the intervention school I-C (N=51) were compared to students in the control group (N=172), students in I-C showed significant reduction in the frequency of consumption of sweetened beverages (I=0.95±0.86, C=1.95±1.16, p<0.000), processed packaged snacks (I=1.22±0.98, C=2.10±1.35, p<0.000), amount of sweetened beverages (I=0.95±0.67, C=1.65±0.93, p<0.000), and processed packaged snacks (I=1.29±0.65, C=1.62±0.66, p=0.018).

Students also showed increase in the consumption of water ($I=3.59\pm1.32$, $C=2.95\pm1.42$, $p=0.026$) and fruit and vegetables ($I=3.25\pm1.24$, $C=2.65\pm1.32$, $p=0.039$). Students also had higher behavioral capability scores ($I=10.71\pm7.18$, $C=4.06\pm1.34$, $p<0.000$) (Table 38).

Table 38: Outcomes among students in I-C versus control schools

	I-C				Control				P
	Pretest		Posttest		Pretest		Posttest		
	N	M±SD	N	M±SD	N	M±SD	N	M±SD	
Frequency									
Processed snacks	51	1.75±1.20	36	1.22±0.98	167	2.31±1.24	91	2.10±1.35	0.000
Sweetened beverages	51	1.48±0.97	36	0.95±0.86	168	2.03±1.10	99	1.95±1.16	0.000
Water	51	3.35±1.26	42	3.59±1.32	167	3.23±1.24	149	2.95±1.42	0.026
Fruit and Vegetables	51	3.19±1.35	36	3.25±1.24	167	2.93±1.27	97	2.65±1.32	0.039
Amount									
Processed snacks*	51	1.57±0.75	36	1.29±0.65	167	1.89±0.69	90	1.62±0.66	0.018
Sweetened beverages **	51	1.42±0.75	36	0.95±0.67	168	1.76±0.86	99	1.65±0.93	0.000
Mediators									
Behavioral Capability	51	4.57±1.64	32	10.71±7.18	156	4.58±4.06	99	4.06±1.34	0.000

($P<0.05$ =significant, $p\geq0.05<1$ =trend)

All variables adjusted for respective baseline and behavioral capability scores

*Frequency Scale: 0-5: (0=never drink this, 1=about 1-2 times per week, 2=about 3-4 times per week, 3=about 5-6 times per week, 4= about once per day, 5=more than 2 times per day.

*Amount Scale (each time): 0-3: 0=never eat this, 1=small, 2=medium, 3=large

**Amount Scale (each time): 0-4: (0=never drink this, 1=less than 12 ounces, 2=about 12 ounces, 3=about 20 ounces, 4=more than 20 ounces.

Time spent Scale (each time):

Behavioral capability Scale: 0-11

CHAPTER-V

DISCUSSION

This chapter provides discussion of the results obtained in this study. It also compares the results obtained from similar studies, explains the strengths and limitations and elaborates on implications and future directions.

The “Creature-101” game is a unique intervention in the field of nutrition education to promote healthy eating and physical activity behaviors among middle school students with an aim to prevent childhood overweight and obesity. It uses “game” as a medium for intervention delivery as opposed to the popular “classroom based curriculum” to promote motivation, engagement, and behavior change among the children and adolescents. It incorporates lessons from a previously tested inquiry based science curriculum in nutrition as its educational content, a concept that has not been explored before. In addition, it uses the latest virtual reality technology in gaming to create a virtual world named “Tween”. By using virtual creature care it aimed to motivate and change eating and physical activity behaviors among children and adolescents. In the field of nutrition education, prior to Creature-101 only one game “Escape from Diab and Nano” used virtual reality in its making. However, in Diab and Nano students role-played the protagonist. This is unlike Creature-101 where the students could create their own avatars, and edit and alter their avatar at will, allowing them to play a more dynamic role. Diab and Nano were computer-based applications so the students could play the game only on computers that had the game installed, while Creature-101 was online that enabled students to play the game on any computer that had access to the Internet. Finally, Diab and Nano focused on primarily three behaviors: increasing fruit and vegetables, water and moderate to vigorous physical activity while Creature-101 addressed the wide range of energy balance related

behaviors that have been found to have an impact on childhood obesity among middle school children and adolescents.

This study assessed efficacy of the Creature-101 game. It was conducted to evaluate if the Creature-101 game that derived its educational content from the “Choice, Control & Change (C3)” curriculum could promote positive behavior changes among its users. The hypothesis of this study was that by playing the game students in the intervention group would improve their eating and physical activity behaviors such as decrease consumption of sweetened beverages and processed packaged snacks, and increase water and fruit and vegetable consumption, decrease recreational screen time activities and increase physical activity. It was also hypothesized that by playing the game students would increase their behavioral capability (knowledge and skills) in nutrition, and other psychosocial mediators of behavior change such as outcome expectation, self-efficacy and autonomous motivation.

Results from this study showed that Creature-101 was effective at decreasing the frequency of processed packaged snack consumption from about 3-4 times per week at baseline to about 1-2 times per week post intervention when compared to a control group. The effect size was small (partial $\eta^2=0.041$).

Additionally, there was a positive trend in decreasing frequency of sweetened beverage consumption from approximately 3-4 times per week at baseline to 1-2 times per week post intervention), opting for smaller sizes of sweetened beverages and processed packaged snacks when compared to a control group.*

A significant increase in behavioral capability (knowledge in nutrition) was noted in the intervention group when compared to the control group.

* As usual intakes were measured instead of actual intakes, true differences could not be calculated. The interpreted values are close approximations.

There were no changes in the other hypothesized behavioral outcomes such as increase in water and fruit and vegetable consumption, decrease in recreational screen time activities and increases in physical activity or the psychosocial mediators of behavior change such as outcome expectation, self-efficacy and autonomous motivation.

The following section provides in depth discussion of the results and compares them with other studies.

Behavioral outcomes

Processed packaged snack

The current study showed a significant decrease in the frequency of consumption of processed packaged snacks ($p < 0.000$) and a trend ($p = 0.08$) in the hypothesized direction for the size of snack consumption. The results are similar to the C3 efficacy study that reported significant reduction in the frequency of processed snack consumption ($p = 0.005$) and a trend ($p = 0.07$) for the size of snack consumption among students in the intervention group. The C3 dissemination study also found a trend in the reduction of processed packaged snack consumption per day ($p = 0.055$).

Besides C3, three other school based interventions also aimed at reducing middle school students high calorie snacking behaviors: “The HEALTHY* Study”, “The Dutch Obesity Prevention Intervention in Teenagers (DOit study)”, and the “Teens Eating for Energy and Nutrition at schools (TEENS Study).” To attain their goals, these studies combined a theory-based and behaviorally focused classroom curriculum component with an environmental

* HEALTHY is not an acronym, it is the marketing name for this multicenter study.

component that made changes in students snacking behaviors. The results were mixed. The DOIt study and TEENS were not able to show any changes in students snacking behaviors, but the HEALTHY study found some positive changes at reducing high fat and high sugar snacks among the children (Lytle et al., 2004; Mobley, 2012; Singh AS, M., J., & W., 2009).

The Creature-101 game provided a scientific rationale (factual knowledge of nutrition) related to personal consequences to get students initially motivated about processed snacks. Students were asked to complete a “French Fries visualization survey” that helped them think about how they felt about French fries and why. Then the game provided food/nutrition facts (procedural knowledge) through mini-games like “Chip Sort” and “Domino game” to enable students to make better snack choices. It also provided students with behavioral skills to analyze their own intakes and set personal goals relevant to them through a guided goal setting process. Later in the game, to reinforce motivation, students learned about the scientific evidence related to long-term health consequences of eating too much processed packaged snacks by viewing the “clogging artery” video.

All these game activities may have motivated the students in the intervention group to reduce their processed snack intake when compared to the control group. Although no significant changes were noticed in the size of processed packaged snack consumption, there was a trend indicating that students reduced their size of snack to some extent. A possible reason for not being able to see changes could be that our instrument was not sensitive to capture these changes. The unit of measurement for size of snacks in the instrument was as: small, medium, and large, and not the actual weights in grams or ounces. These measurement units were used to make the response options easier for students. However, this general unit of measurement might not have been able to capture real changes if there were any.

Since the frequency of consumption of processed packaged snacks was highly significant it was expected that we would observe a dose response relationship of playing the game for this behavior. However, game play did not significantly predict the positive outcomes. It could be that the available data was inadequate to capture the effects of the particular game activities that may have motivated the students to make behavior changes. More data on the number of times the students played the mini games, the number of attempts they took to successfully complete each mini games etc may have possibly explained the game dose effects. These data were not collected in the study as they were not among primary study outcomes, and the game server was not programmed to do so.

Sweetened beverages

This efficacy study found that the students showed positive trends ($p < 0.1$) at reducing frequency of sweetened beverage consumption, and choosing smaller sizes (amount) of these drinks. These results were not as expected. The C3 efficacy study reported that the curriculum produced highly significant changes in the frequency ($p < 0.001$) and amount of consumption ($p < 0.001$) of sweetened beverages (Contento et al., 2010). The dissemination study also reported significant changes in the frequency ($p = 0.022$) of consumption of sweetened beverages. Other studies with middle school students “The DOit” and “HEALTHY” that aimed at reducing sweetened beverages reported mixed results. The DOit intervention, like C3, was effective at reducing the sweetened beverage consumption, but the “HEALTHY study” failed to do so.

To understand these results, the changing school food policies that have occurred over time must be considered, as that may have been a particularly important factor. The Child Nutrition and WIC Reauthorization Act of 2004 required that local education agencies address childhood obesity by developing school wellness policies (Child Nutrition and WIC

Reauthorization Act, 2004). However, according to the Institute of Medicine's Report most of the recommendations were not effective till 2006-2007 (Greves & Rivara, 2006). Now the policies are gradually being put into place. In 2010, the New York City Department of Education (NYC DOE) affirmed its commitment to the role of schools in promoting wellness by revising and significantly raising the bar in its updated School Wellness Policies. The introduction of the revised NYC DOE Wellness Policies in 2010 generated a significant shift in not only what foods are served in schools, but also in spreading a new cultural awareness about how to support student health. Effective from February 2010, only foods and beverages that met the Department of Education School Food Guidelines could be offered during school hours. For middle schools, the permitted beverages were water and low calorie drinks without artificial sweeteners with 10 calories per 8 ounces (New York City Department of Education, 2011). According to a press release by the Robert Wood Johnson Foundation (2012) the percentage of middle school students who could buy soda at school nationwide decreased, from 27 percent in 2006-07 to 13 percent in 2010-11, and the number of middle school students with access to sports drinks at school also declined significantly, from 72 percent to 55 percent (Robertwood Johnson Foundation, 2012). These policy changes may have effected students' consumption of soda and other sweetened beverages in schools.

It was also noticed that students in the current study had reported lower consumption of sweetened beverages in terms of frequency (about 3-4 times per week) and size (less than 12 ounces) at baseline compared to the average consumption of sweetened beverages among children and adolescents in NYC, and hence may have had less scope for improvement. According to the data released by the NYC Department of Health and Mental Hygiene the average consumption of sweetened beverages among children between 6-12 yrs is *at least* one 12

ounce size of sweetened beverage per day (New York City Department of Health and Mental Hygiene, 2011). National data on consumption of sweetened beverages according to CDC report is that boys aged 12–19 yrs consumed an average of 22.0 ounces of full-calorie soda drink per day and girls consumed an average of 14.3 ounces of full-calorie soda per day (Sebastin, Cleveland, Goldman, & Moshfegh, 2006; Wang, Khoo, Woon Chia, & Divaharan, 2008). Both are higher than the amounts reported by the participants in this study.

Secondary analysis of data from the study found that the game was a significant predictor of sweetened beverage consumption (both frequency and amount). This was expected as several game activities were directly linked to consumption of sweetened beverages. Sweetened beverage was the first behavior that was addressed in the game. A slideshow “Understanding taste” provided scientific rationale about why we as humans loved sweet foods. It also provided students with food and nutrition facts about the sugar content of the commonly consumed sweetened beverages through a mini game “Sugar-rush sort”. Students were provided with goal setting skills to reduce their sweetened beverage consumption. In addition, scientific rationale about the long-term consequences of drinking sweetened beverages was provided with the help of an educational “diabetes video”. These game activities may have been motivating factors for the students.

Water

Frequency and amount of plain water⁹ consumption by students were measured in this efficacy study. The game did not change consumption (either frequency or amount) of water.

⁹ Intake of plain water defined by the NCHS is to include tap water, water from a water cooler or drinking fountain, spring water, and noncarbonated bottled water.

The C3 efficacy study also did not report any change in water consumption and the dissemination study did not measure this behavior. Of the middle school based obesity prevention studies only “The DOit” study and “HEALTHY ”aimed at increasing students water consumption other than C3. Like C3, the DOit study did not see any changes in students’ water consumption although the students reported having decreased their sweetened beverage intake. The HEALTHY study was successful at increasing students’ water intake by 2 fluid ounces a day.

Consumption of water is usually very hard to measure as it is difficult to remember how many times per day and in what amounts one drinks water. As a result there is paucity of research on water consumption in general and also for this population (Food and Nutrition Board, 2004). It is reasonable to mention here that validation studies of the “Eat-n-Play: What You Do” instrument that measured students eating and physical activity behaviors did not show high reliability for the water items. The internal consistency values for bottled and tap water were low ($r=0.044$). This suggests that the instrument was less reliable at measuring students’ water intake accurately.

In the game drinking water was promoted. Students learned the fact that water was a “zero calorie” drink and was freely available from water fountains (to also promote consumption of tap water and use of reusable water bottles). They learned the scientific evidence that drinking water instead of sweetened beverages could help them be in energy balance. However, there was no game activity that provided scientific rationales to why drinking water was important, or the consequences of not drinking enough water on a long term. Maybe having more game activities that directly targeted “water intake” or promoting the benefits of water would be beneficial at changing this behavior.

Fruit and vegetables

Creature-101 was not effective at increasing fruit and vegetable consumption among the intervention students. The C3 efficacy study too failed to show improvement in fruit and vegetable consumption in children (the dissemination study did not measure fruit and vegetable intake).

Most school based intervention studies that aimed at reducing childhood obesity have focused on increasing fruit and vegetable consumption, and have shown little success. Planet Health improved fruit and vegetable consumption in girls (not boys) by 0.32 servings per day. The HEALTHY study reported a 10% increase in only fruit consumption among students in the intervention schools when compared to the controls. TEENS study also did not show any positive changes. However, the video games “Diab and Nano” were effective at increasing fruit and vegetable intake among its students by 0.67 servings per day.

Literature shows that fruit and vegetable intake among children and adolescents depends on several factors. A review of determinants of fruit and vegetable consumption among children and adolescents revealed that the determinants included socio-economic, personal, home and school level factors (Rasmussen et al., 2006). The determinants supported by the greatest amount of evidence were socio-economic position (demographic factor), preferences, nutritional knowledge (personal factor), parental intake, and home availability/accessibility (home factor), and availability at school. Low socio-economic position is associated with low or less frequent intake of fruit and vegetables, and especially for low family income. Home and school availability is directly linked with intake. The students in our study came from primarily low-income families and hence may be that fruit and vegetables were not available at home. However, middle-school breakfast and lunch in NYC provide fruit and vegetables regularly that

the children could consume even it was not readily available at their homes. There is a positive association between preferences and children and adolescents' intake of fruit and/or vegetables. Nutritional knowledge is also positively associated with intake. Positive associations are also observed for attitude, intentions, self-efficacy, and subjective norms (perception of others' attitude on own diet) (Rasmussen et al., 2006). Other studies have also indicated similar results (Di Noia & Contento, 2010; Krolner et al., 2012; Lorson et al., 2009; McClain, Chappuis, Nguyen-Rodriguez, Yaroeh, & Spruijt-Metz, 2009; van der Horst et al., 2007).

The Creature-101 game focused on personal factors and promoted behavioral capability (knowledge and skills) about eating fruit and vegetables. Students played a matching puzzle mini-game that taught them about the benefits of eating fruit and vegetables of different colors. They were also encouraged to feed their adopted creatures plenty of fruit and vegetables to keep them in energy balance. However, it was not possible to address environmental, home and school level factors in the game. This may explain to an extent why no changes in fruit and vegetable intake were seen.

Recreational screen time activities and physical activity

The Creature-101 efficacy study did not find any decrease in students' recreational screen time activities such as watching TV and playing video games for entertainment or increase in students' physical activity. These results were different as the C3 efficacy study and its dissemination study both showed significant reductions in the frequency and time spent on screen time activities. The C3 efficacy study also showed significant outcomes in terms of increase in purposeful walking instead of using public transport ($p < 0.001$), walking for exercise ($p = 0.004$), and purposefully taking the stairs ($p < 0.001$). However, the students in this study reduced their frequency of recreational screen time behaviors from approximately 5-6 times per

week to 3-4 times per week though not significant when compared to a control group. It can be noted here that the Creature-101 game was sedentary by itself, and did not provide opportunities to be physically active.

Other studies that focused on reducing screen time behaviors were Planet Health, DOit and HEALTHY, both of which have reported positive changes in reducing screen time activities. Planet Health reported that the boys in the intervention had significantly reduced their screen time behaviors by 0.4 hrs per day and the girls by 0.58 hrs per day. The DOit study reported that the boys in the study (not girls) had reduced their screen time activities by 25 minutes per day after 20 months of the intervention. The HEALTHY study also aimed at reducing screen time behaviors but reported no positive changes. However, all the mentioned studies failed to show desirable changes at increasing physical activity among children. Overall, a systematic review by Metcalf et.al found that physical activity interventions, on average, achieved small to negligible increases in children's total activity volume, with small improvements in the time spent in moderate or vigorous intensity activities, and were not very effective at reducing adiposity (Metcalf, Henley, & Wilkin, 2012).

What factors promoted changes in both physical inactivity and activity habits are difficult to understand from the literature. In C3, the physical activity component had students keep a personal 24-hour physical activity log. Students were provided with pedometers that could actively monitor their steps. Students were asked to set an activity goal of 10,000 steps per day. These activities may have motivated students to be more physically active. In Planet Health the Physical education materials focused on activity and inactivity themes and included student self-assessments of activity and inactivity levels and goal setting and evaluations for reducing inactivity, replacing inactive time with moderate and vigorous physical activities of their

choosing. This study found decrease in TV viewing but no change in physical activity. In the DOit study students were asked to use bicycles as the means to actively commute to school and asked to reduce their sedentary behaviors through active social marketing messages (this study was conducted in the Netherlands where bicycle use was common). They found reduction in sedentary behaviors but no improvement in physical activity. The HEALTHY Study included physical education as an intervention component with a goal to achieve more than 150 minutes of moderate to intense physical activity per day in physical education classes every 10 school days. This study found no changes in either sedentary habits or physical activity. On the other hand, The Middle School Physical activity and Nutrition study (M-SPAN) that focused on active physical education classes showed positive changes in physical activity behaviors in boys (not girls). Hence, what works for increasing physical activity among children is inconclusive.

Creature-101 included game activities that discouraged recreational screen time behaviors and promoted physical activity. The story line for Creature-101 began stating that the creatures became sick by eating too many junk foods and watching TV. As the game progressed and the students had to balance the “energy gauge” to maintain the health of their creatures they noticed that the gauge could not be balanced if their creatures were allowed too much TV or video games, while physical activity helped them be in energy balance. These intervention components may not have been strong and effective to promote physical activity among students. In addition, there may have been some confounding effects due to the time (season) of program delivery. The students in the intervention group participated in the research between October and March and the students in the control group participated in March and May-June. Considering this fact we may assume that the students in the intervention group were not able to play outdoors due to the climatic conditions.

“Escape from Diab” and “Nano” also aimed at increasing physical activity in students and did not find any positive changes. In another research study, Baranowski et. al set out to test whether children receiving a new (to them) active video game spontaneously engaged in more physical activity than those receiving an inactive video game. They found that there was no evidence that children receiving the active video games were more active in general, or at anytime, than children receiving the inactive video games (Baranowski et al., 2012). Hence, the results of Creature-101 are in line with evidence from literature.

Behavioral capability and psychosocial outcomes

Improvement in Behavioral capability (nutritional knowledge) has been effectively tested in some middle school obesity prevention studies and has been found to be a mediator of dietary behaviors as well (Reynolds et al., 2004; Reynolds et al., 2002). The Creature-101 intervention provided behavioral capability (both knowledge and skills) to its players. As a result of playing the game, the students in the intervention group reported significant increase in behavioral capability when compared to the control group. Students in the intervention group showed a single point increase in behavioral capability (knowledge) scores from baseline (Scores ranged from 0-11). An early review by Connell et. al had suggested that in order to produce a small effect in program specific knowledge, a minimum of 5 intervention hours is required (Lytle, Seifert, Greenstein, & P., 2000). Thus, considering the brief duration of this intervention (3-1/2 hours), a single point increase in students’ knowledge scores may be considered relevant.

Data were further explored to understand the change in behavioral capability scores among students. The intervention group consisted of four schools. Among these schools, one school (I-C) had higher reading scores (not significantly different) when compared to the other three. The changes in behavioral capability scores between I-C and the other three schools from

baseline to post-intervention were analyzed. The results showed that for I-C, the pre-post behavioral capability means changed from 4.04 ± 1.71 to 10.06 ± 7.16 and for the other three schools (averaged together) from 4.10 ± 1.43 to 4.65 ± 1.59 . These results indicated that the behavioral capability scores were possibly dependent on the students' ability to read and comprehend English language.

The Flesch Kincaid readability scores that indicate comprehension difficulty when reading a passage of contemporary academic English for Creature-101 game activities were assessed using Microsoft Word. The Flesch Kincaid scores for Grade level for Creature-101 activities ranged from 3.1-3.6, indicating that the text could be easily read by students in third grade. However, the average reading score percentage of the three schools was 25.1% (meaning only 25.1% of students at the three schools were at grade level for reading). Hence, poor reading skills of students may be a factor that effected positive outcomes on behavioral capability scores.

This study did not find any changes in self-efficacy, outcome expectation (social and physical) and autonomy for any of the targeted behaviors. However, in the game self-efficacy was promoted by providing behavioral skills to set personal food and activity goals and following them through. Behavioral capability (skills) that helped students make better choices could also promote self-efficacy among students. Outcome expectation were provided through providing scientific rationale for personal consequences of doing a behavior and by providing evidence of the long-term consequences of those behaviors. For an example the “diabetic video” and “clogging of arteries video” aimed at promoting the negative consequences of eating excess of sugar in drinks and fat in processed snacks respectively. Autonomous motivation was provided through the motivational dialogues in the game storyline. Students were provided with an “autonomy supportive” environment as they entered into the game world as “saviors of their

creatures”. Mastering the challenges of the creature caretaking processes helped instill “competence” in them.

These results are different from the original C3 efficacy study that reported significant changes in students’ self-efficacy in all the behaviors. Two possible reasons could contribute to these findings. The most likely cause is that our instrument though valid and reliable was not sensitive to capture the changes. The other plausible explanation could be that the low reading ability of the students could interfere with their understanding the game concepts and activities. This could also explain, to some extent, the poor overall outcomes of this efficacy trial.

The results presented above were reflective of the “Intention to Treat” analysis where the analysis was based on data from all students who participated in the intervention, irrespective of how far they proceeded in the game. In an additional analysis conducted with the subset of students who completed the game i.e reached the highest level (Level-4) in the game, the following results were found: significant decrease in the frequency of sweetened beverages, processed packaged snacks, amount of sweetened beverage consumption, and behavioral capability. A positive trend was observed for the decrease in size (amount) of processed packaged snacks. This showed that the students who completed more game activities showed better outcomes.

Other causes effecting outcomes

Length of the intervention may have impacted the study outcomes. The Creature-101 intervention lasted for about 2-4 weeks (approximately 7 sessions, 30 minutes each) and entailed 3.5 hours of game play. The original C3 efficacy trial was conducted over 8-10 weeks and consisted of 24 lessons, where each lesson was 40 minutes each, but some took more than one class to teach (approximately 24-35 hours of intervention). The dissemination study was shorter

than the C3 efficacy but it consisted of 19 lessons (16 lessons were taught), 40 minutes each over 4 weeks (approximately 10.5 hours of intervention). Literature suggests that there appears to be a generally positive association between intervention dose and dietary behavior improvement. Early reviews of school-based interventions concluded that 10-15 hours of classroom education could produce only minimal changes, while stable medium effects (between 0.5 and 0.8 percent of a standard deviation) on behavior aren't observed until intervention contact reaches 50 hours (Lytle et al., 2000) (Contento et al., 1995; Contento, Manning, & Shannon, 1992; Olander, 2012). The video game "Diab and Nano" that showed positive outcomes in the students' fruit and vegetable consumption consisted of eighteen sessions (40 minutes per session and 6 hours of game play for each) of about 12 hours of game play.

Implementation fidelity: In an additional analysis conducted with students in the intervention school (I-C) where the intervention was delivered with maximum fidelity, the students reported better pre to post intervention outcomes (significant changes in the frequency and amount of sweetened beverages and processed packaged snacks, in the frequency and time spent in recreational screen time activities). When students of this school were compared with students of the other intervention schools, students also showed better outcomes (significant decrease in the frequency and amount of sweetened beverages and processed packaged snacks, increase in frequency of drinking water, reduction in time spent in recreational screen time activities, increase in behavioral capability scores). These results suggest that implementation fidelity may be associated with study outcomes. Since, the implementation at all intervention schools was not as planned, the study failed to show desirable outcomes.

Academic capability of students: When the students in the intervention school I-C were compared to the students in the control group, they showed better outcomes in terms of

decreasing frequency and amount of consumption of sweetened beverages and processed packaged snacks, increasing intake of water and fruit and vegetables, and increased behavioral capability scores. These results suggest that in addition to implementation fidelity, there may be other factors such as academic capability that can moderate study outcomes. Further research is warranted.

Targeting several energy balance related behaviors in a single short-term intervention could also be a potential problem. Though it is reasonable to address the whole range of energy balance related behaviors in a single intervention to promote healthy eating and physical activity, but considering the very brief period of the intervention, it may not have been ideal. Choosing few behaviors could have enabled researchers to develop more content related to each, hence increasing the dose of the intervention. This may have warranted better outcomes.

Instrumentation effect in the control group may also account for overall study outcomes. For most outcomes it is evident that the control group showed positive changes even though they did not receive the intervention. It can be noted here that the pre and post-test surveys were administered within a period of seven to ten days in the control group. This might have caused “instrumentation effects” where the students may have assumed that the researchers were looking for desirable answers.

Sedentary nature of the game: The game itself was sedentary by itself. Though it promoted physical activity in various game activities, it did not actively engage students in physical activity. It denounced recreational screen time behaviors like watching TV and playing recreational video games, but playing the game was sedentary by itself. Hence, it may have been difficult to promote physical activity by just playing the game itself.

“Creature-101” compared to “Diab and Nano”

In the field of nutrition education currently there are two games “Diab and Nano” and “Creature-101” that are meant to promote healthy eating and physical activity behaviors among middle school students.

These games are similar as they both used Social Cognitive and Self-Determination theories in their theoretical models. Both promoted eating fruit and vegetables, drinking water and increasing physical activity. Creature-101 targeted sweetened beverages, processed packaged snacks intake in addition to the above. Both used an attractive storyline in a virtual world, and targeted middle-school students. However, there were major differences by the way the games were developed in terms of content and implemented for their efficacy trials.

Diab and Nano consisted of eighteen sessions (40 minutes per session and 6 hours of game play for each) of about 12 hours of game play. Each session in Diab and Nano had a knowledge mini-game designed to provide practical knowledge related to change goals. Energy balance was divided into 18 sequential learning activities such that each ensuing learning session was predicated on mastering that material, which built on material in the previous session. Goal setting included action and coping (anticipatory problem solving) strategies. In Creature-101, the overall game play consisted of 7 sessions of 30 minutes of game play. The game activities would follow a definite sequence but there was no recap of activities. No knowledge mini game was played to periodically check students’ learning outcomes (in our case behavioral capability-nutrition).

The Diab and Nano study was conducted in the students’ homes where a 24inch Mac loaded with the game was provided, unlike Creature-101 that was implemented in real classrooms. Students who played Diab and Nano could play the game whenever they wanted

according to their schedules and could take any amount of time to finish each session. The research staff monitored or intervened only when the students had not completed a desired number of activities. In Creature-101 students completed the game within the specified time. It is possible that the students who participated in the Diab and Nano study were already motivated to make behavior changes, or participated in the study because of the monetary incentives provided by the researchers. This is unlike Creature-101 where all students with different levels of motivation played the game in real class time as a classroom activity.

In spite of these major differences in the game content and its implementation, the results were not vastly different. Diab showed improvement in fruit and vegetable intake and Creature-101 showed improvement in the frequency of processed packaged snack consumption. This leaves the field of nutrition education open to the possibility of conducting more research in the area of virtual reality games and promotion of nutrition and physical activity behaviors.

Strengths of the study

This efficacy study had several strengths. The study is unique as it used an engaging and innovative virtual reality technology (as virtual creature care) in game design to disseminate a nutrition science curriculum to promote healthy behaviors in this age group for the first time. Previous studies in nutrition so far had used a strong story line with fascinating game characters but by creating self-representations of themselves, by creating avatars in the game, the students experienced a sense of relatedness to the characters.

The game was also unique in terms of its content selection. It used a prior tested curriculum in nutrition science to build in the game activities. The activities in the curriculum were transformed into mini-games, slideshows, motivational dialogues, and educational videos and incorporated into the game.

The game was self-explanatory and the protagonist “Murphy” helped students to move in the game from one activity to another and also from one game level to another. This reduced the burden from teachers to have to create lesson-plans on a daily basis, or be actively involved during the intervention.

This efficacy study was implemented and tested in real classrooms. This is unlike the other games in nutrition “Diab and Nano” and Squire’s Quest (for elementary school students). In Diab the students were provided with the pre-installed game for their homes as we have noted so that they could play the game at their convenience. For Squire’s quest the researchers moved computers from one school to another. Neither of these games were tested in real world classrooms.

This efficacy study used two validated instruments to measure study outcomes. Eat-n-Play: What You Do measured behavioral outcomes, and Eat-n-Play: What You Think measured behavioral capability and psychosocial mediators. Both instruments showed acceptable validity and reliability, suggesting that the lack of stronger results was not due to the instruments.

All the data collected for the study were online through “Survey Monkey”. This enabled the researchers to upload bigger files of colored pictures that were used in the survey. This enabled students to understand the survey questions better. It also reduced printing costs. Another advantage was that the data were directly inputted into excel files from the survey monkey website. Thus, it did not require additional resources for data entry and also minimized chances of human error during data entry.

Limitations of the study

The study had several limitations. The study used a matched pair quasi-experimental design as opposed to a randomized control trial. A pair wise matching of schools was done

before assigning schools into the intervention and control conditions. This process enabled removal of confounding variables that could have an effect on the intervention outcomes (Lakshman, Sharp, Ong, & Forouhi, 2010). However, it does not guarantee complete removal of all the confounding variables in the sample (Bonnie & Martin, 1998). This method was chosen over a true randomized control design as the game engineering took too long to complete than expected, and the time between game implementation in the schools and project completion did not allow enough time to get approval from all the schools and randomize. The recruitment and implementation were done simultaneously.

The study was conducted with unequal groups. There were fifteen intervention classes and seven control classes. Two schools in the control condition that did not participate in the study as previously indicated due to their schedules. However, the total number of students was large so it permitted substantial assessment of game play. Unequal sampling was also used in the efficacy trial of Diab and Nano. However, it is also important to note that balanced group sizes would help maximize a study's statistical power and the use of unequal groups may significantly reduce the power of a study (Dumville, Hahn, Miles, & Torgerson, 2006). Thus, this study may not have the required power to detect changes of the intervention.

Use of a concurrent control group is recommended in experimental designs to prevent the threats of unplanned events unrelated to the intervention that might impact outcomes (Cook & Beckman, 2010). It is also suggested that the control group should be treated in a defined way as part of the same trial that studies the test treatment, and over the same period of time (Diehl & Perry, 1986). This study did not have concurrent control groups as the schools that were in the control group could not begin the study at the same time as the intervention schools due to their academic schedules. Of the two control schools, only one completed the study concurrently with

the intervention schools in March. The other completed the study in May-June. Thus, it is reasonable to assume possible confounding of weather impacting physical activity outcomes. Also, students in the control group were not in the study for an equal amount of time. The schools in the control group refused to allow students to play the control game “Whyville” for more than two sessions. Thus, the students in the control schools were administered the pre and post-test surveys within one week. This may have resulted in instrumentation effects that may have impacted the overall outcomes of this study.

The data used to measure outcomes were self-reports by students, and hence there is always a possibility of recall bias. The most common problems associated with self-reported data is either over-reporting or underreporting. However, self-reported surveys are the most common method of data collection as found in literature, and hence the current study is no exception.

The instruments used for measuring outcomes had acceptable validity and reliability scores, but they may not have been sensitive enough. To be sensitive an instrument must be able to detect small, but clinically significant changes in a phenomenon over time (Wallen, Cunningham-Sabo, & Auld, 2009).

The statistical analysis in this study did not use a correction method for multiple testing. This efficacy study was meant to be a confirmatory trial confirming the efficacy of the Creature-101 game, but no previous formative or exploratory study was done to establish the hypotheses for this current study. Hence, this efficacy trial maybe considered as an exploratory study in some sense. In exploratory studies, in which data are collected with an objective but not with a pre-established hypotheses, multiple test adjustments are not strictly required (Bender & Lange, 2001). P-value adjustments reduce the chance of making type I errors, but they increase the chance of making type II errors or needing to increase the sample size (Feise, 2002). Hence, it is

better to tolerate findings that may later prove to be false than to prematurely discard potentially useful observations because of type 2 errors caused by corrections for multiplicity (Streiner & Norman, 2011). However, the possibility that the significant finding for processed packaged snack intake may have been due to chance given the number of statistical tests conducted in the analysis cannot be completely ruled out.

The survey data were collected online. There was a potential problem with missing responses. Several students did not provide responses to all the questions in the survey. However, missing data in diet surveys is common among children and adolescents. It may be that the students did not provide a response to a question as he/she hurriedly wanted to complete the survey, or may have clicked a response option that was not recorded by the web server. It is also possible that the students did not want to provide an answer to a particular question. Most online surveys use “*this question requires an answer*” option to get “forced responses” from the participants. However, this option was not used in this research as it violated the terms of the IRB approval.

The study did not have a follow-up assessment. Hence, it is not possible to assess if the positive trends in behavioral outcomes were retained by the students’ over time. A follow up study was not possible due to lack of financial resources and time. The grant period ended before the study could be completed due to logistical problems of game engineering and implementation in the schools. However, most nutrition education intervention studies do not have a follow up assessment.

The study was implemented with several barriers. Recruiting adequate matching schools and classes for the study was difficult. Several schools that were interested in the program either refused or backed off from participating due to excess pressure on them to get the students ready

for state English and Mathematics tests, or had limited amount of instructional time allocated for health and nutrition education. Most schools lacked computer carts for individual classrooms and students had to use the computers that were available to them through the school's computer lab. These labs were used by all students in the school hence they had to be booked weeks ahead of time to be used for our program. Many schools had fewer computers than the number of students in the classes. Under these circumstances students had to share computers. However, our program required that all students be assigned to a computer. The Internet connectivity was poor at all schools but one, and this caused frequent interruption in game implementation. Besides, there were occasional malfunctioning with the Creature-101 game website. When more than 25 students logged in to the game at the same time the server slowed down and the students had to wait several minutes for a web page to download. There were few occasions when the game website froze and the students could not play any further. These issues caused interruptions during implementation. Students lost interest in the game during these times. It also led to occasional problems of classroom management. At one time the history for all students were wiped out due to a crash in the game back-up program and the students had to create their avatars and creatures again. However, most of the data was later recovered and the sessions were restored and the students could resume play from where they had left off.

Implications for research and practice

This study shows that a virtual reality based game using “virtual creature care” is encouraging and may be able to promote healthy diet and physical activity behaviors among children and adolescents. Research in this area is open to an array of interesting problems that can be investigated. Future research can investigate what aspects of a story or narrative are critical to immersing the participant in a game, what aspects of environments need to be captured

in virtual realities to maximize effectiveness of simulations, what aspects of an avatar are necessary to optimize learning, and what activities can be used to maximize behavior changes. Research can also investigate how the game can be expanded and keep the players involved for a greater length of time so as to increase the dose of the intervention and thus result in substantial changes in behavior.

In terms of practice, it the game can be used in science or health education classes to teach children about nutrition science in an innovative way. The program can be delivered in less time than a regular curriculum in nutrition and it reduces burden on the teachers to prepare for classroom teaching. It can also be used in after school programs where nutrition education can be provided to the children by the counselors and staff of these programs in the absence of a qualified nutrition educator because the game is self-explanatory and does not require expert involvement. Another area of use maybe the home school and virtual school markets. These are growing exponentially in the United States. Creature-101 shows promise as a form of a distance learning platform for the delivery of nutrition education to children and adolescents to help them adopt a healthy lifestyle.

Future directions for research

The Creature-101 game showed some encouraging results at promoting healthy eating behaviors among middle school students. Based on findings from the current research it is imperative that further research in the area of nutrition games should be done. However, caution is required when selecting the targeted behaviors in the game. Possibly a couple of behaviors could be addressed at a single time. As students master the content and show evidence of improvement in those behaviors, can then be moved to another set of behaviors that need to be modified.

The games can be made more appealing to students and have the potential to attract all students irrespective of their academic skills. Game narratives can provide more fun and improve interactions between the game characters. This could also reduce the burden of reading game dialogues by the students.

Creature-101 had unique social networking features. Students could create groups and share their experiences with their friends. They could keep track of their own progress. However, these networking features were disabled during the game implementation as students spent more time with these features than playing the game itself. It was also felt that strict monitoring of the Creature-101 website was required to provide more security to the students to be used in the schools. Future studies should incorporate social networking features into games with caution and provide ways to minimize student distractions. The efficacy of social networking at promoting healthy eating and physical activity behaviors in this age group should also be tested.

To avoid implementation issues the games server capacity must be increased. It should be large enough to accommodate at least several hundred students at each time. The games can also be modified and developed for using in handheld devices like smartphones and tablets. These devices are cheaper and more affordable. Public schools with limited financial resources are now more inclined towards getting tablet computers for their students in place of desk top or laptop computers.

Research in this field is fast ongoing and hopefully will be able to document substantial and stable behavior changes among school aged children and adolescents thereby reducing the burden of childhood obesity and occurrence of chronic diseases in future.

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APPENDIX-A

Creature-101 Consent Forms

TEACHERS COLLEGE
COLUMBIA UNIVERSITY

Creature 101: An Educational Computer Game for Healthy Eating and Active Living

Dear families,

We work at Teachers College at the Center for Food & Environment creating and evaluating activities to teach children about healthful eating and getting ample physical activity. Your child's class will participate in one of our projects.

DESCRIPTION OF THE RESEARCH: Your child is invited to participate in a research study evaluating a new computer game called Creature 101. This is a computer simulation game based off of the Linking Food and the Environment (LiFE) Curriculum. The children in your child's class will play the computer game. In classroom, one or two research staff will observe students playing games to see how well the game play goes. Before your child plays the game we will give him or her a survey that asks questions about food and physical activity. Your child will complete the same survey after playing the game. We will also give your child a survey that asks him or her to give us suggestions for how to improve the game, and to describe what he or she liked, or did not like about the game.

RISKS AND BENEFITS: The benefits are for your child to potentially learn some about food, health, disease prevention through playing the game. The research has the same amount of risk students will encounter during a usual classroom activity. If your child has any uncomfortable feelings about the game or surveys, he or she can talk to us.

DATA STORAGE TO PROTECT CONFIDENTIALITY: Any information that we collect about your child will be kept confidential. We will use code numbers for each of the children who complete the surveys. The surveys will be stored in locked filing cabinets.

TIME INVOLVEMENT: The students will spend about 6–8 class periods on the Creature 101 intervention. The students will also complete the survey in school before and after the game.

HOW WILL RESULTS BE USED: We will use these data to help us understand how the Creature 101 game influences children's thinking about and choices about food and physical activity.

If you would like your child to complete participate in this research, please sign the back of this page and send it to us using the self-addressed stamped envelope that we provided. We have given you two copies so you have one to keep for yourself. Participation in this study is entirely voluntary and choosing not to participate or withdrawing from participation at any time will not result in any negative consequences to your child.

If you have any questions you may contact us at 212/678-3001. You can also contact the Teachers College Columbia University Institutional Review Board (IRB) at (212) 678-4105. Or, write to the IRB at 525 W. 120th Street Box 151, New York, NY, 10027.

We look forward to working with your child's class.

Sincerely,

Isobel Contento

Pamela Koch

BOX 137, 525 WEST 120TH STREET, NEW YORK, NY 10027-6696 • (212) 678-3480 • LiFEatTC@columbia.edu • www.tc.edu/life

TEACHERS COLLEGE, COLUMBIA UNIVERSITY	
INSTITUTIONAL REVIEW BOARD	
Protocol #	09-134CR2
Consent form #	311/2012
IRB Signature	SHIMB

TEACHERS COLLEGE
COLUMBIA UNIVERSITY
 PARTICIPANT'S RIGHTS

Principal Investigators: *Isobel Contento and Pamela Koch*

Research Title: *Creature 101: An Educational Computer Game for Healthy Eating and Active Living*

- I have read and discussed the Research Description with the researcher. I have had the opportunity to ask questions about the purposes and procedures regarding this study.
- My child's participation in research is voluntary. I, or my child, may refuse to participate or withdraw from participation at any time without jeopardy to future classroom activities or programs.
- The researcher may withdraw my child from the research at his/her professional discretion.
- If, during the course of the study, significant new information that has been developed becomes available which may relate to my willingness to continue to participate, the investigator will provide this information to me.
- Any information derived from the research project that personally identifies my child will not be voluntarily released or disclosed without my separate consent, except as specifically required by law.
- If at any time I have any questions regarding the research or my child's participation, I can contact the investigator, who will answer my questions. The investigator's phone number is (212) 678-3001.
- If at any time I have comments, or concerns regarding the conduct of the research or questions about my child's rights as a research subject, I should contact the Teachers College, Columbia University Institutional Review Board (IRB). The phone number for the IRB is (212) 678-4105. Or, I can write to the IRB at Teachers College, Columbia University, 525 W. 120th Street, New York, NY, 10027, Box 151.
- I should receive a copy of the Research Description and this Participant's Rights document.
- Written materials produced by my child:
 - ☐ may be viewed in an educational setting outside the research
 - ☐ may NOT be viewed in an educational setting outside the research.
- My signature means that I agree to have my child participate in this study.

Guardian's Signature/consent: _____ Date: ____/____/____

Name (please print): _____

Child's name: _____

Child's class: _____ Child's Teacher: _____

BOX 137, 525 WEST 120TH STREET, NEW YORK, NY 10027-6696 • (212) 678-3480 • LIFeATC@columbia.edu • www.tc.edu/life

TEACHERS COLLEGE, COLUMBIA UNIVERSITY
 INSTITUTIONAL REVIEW BOARD
 Protocol # 09-134CR2
 Consent form approved until 3/1/2012
 IRB Signature SHIMB

TEACHERS COLLEGE
COLUMBIA UNIVERSITY

Creature 101: An Educational Computer Game for Healthy Eating and Active Living

Dear families,

We work at Teachers College at the Center for Food & Environment creating and evaluating activities to teach children about healthful eating and getting ample physical activity. Your child's class will participate in one of our projects.

DESCRIPTION OF THE RESEARCH: Your child is invited to participate in a research study evaluating a new computer game called Creature 101. This is a computer simulation game based off of the Linking Food and the Environment (LiFE) Curriculum. Before your child plays the game he or she will complete a survey that asks questions about food and physical activity on two different occasions. After completing the survey twice the children in your child's class will play the computer game.

RISKS AND BENEFITS: The benefits are for your child to potentially learn some about food, health, disease prevention through playing the game. The research has the same amount of risk students will encounter during a usual classroom activity. If your child has any uncomfortable feelings about the survey or the game, he or she can talk to us.

DATA STORAGE TO PROTECT CONFIDENTIALITY: Any information that we collect about your child will be kept confidential. We will use code numbers for each of the children who complete the surveys. The surveys will be stored in locked filing cabinets.

TIME INVOLVEMENT: The students will spend one class period completing the first survey, about 8-10 class periods playing the game and one class period completing the survey after the game.

HOW WILL RESULTS BE USED: We will use these data to help us understand how the Creature 101 game influences children's thinking about and choices about food and physical activity.

If you would like your child to complete participate in this research, please sign the back of this page and send it to us using the self-addressed stamped envelope that we provided. We have given you two copies so you have one to keep for yourself.

If you have any questions you may contact us at 212/678-3001. You can also contact the Teachers College Columbia University Institutional Review Board (IRB) at (212) 678-4105. Or, write to the IRB at 525 W. 120th Street Box 151, New York, NY, 10027.

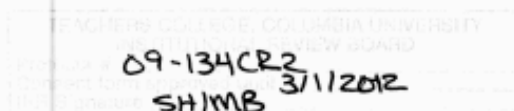
We look forward to working with your child's class.

Sincerely,

Isobel Contento

Pamela Koch

BOX 137, 525 WEST 120TH STREET, NEW YORK, NY 10027-6696 • (212) 678-3480 • LIFEatTC@columbia.edu • www.tc.edu/life



TEACHERS COLLEGE
COLUMBIA UNIVERSITY

ASSENT FORM FOR STUDENTS (Class)

Principal Investigators: Isobel Contento and Pamela Koch

Research Title: *Creature 101: An Educational Computer Game for Healthy Eating and Active Living*

I _____ (child's name) agree to participate in the study entitled: ***Creature 101: An Educational Computer Game for Healthy Eating and Active Living***. The purpose and nature of the study has been fully explained to me by **Pamela Koch**. I understand what is being asked of me, and should I have any questions, I know that I can contact Pamela or one of her staff at any time. I also understand that I can to quit the study any time I want to.

Name of Participant: _____

Signature of Participant: _____

Witness: _____

Date: _____

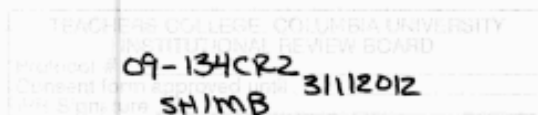
Investigator's Verification of Explanation

I certify that I have carefully explained the purpose and nature of this research to _____ (participant's name) in age-appropriate language. He/She has had the opportunity to discuss it with me in detail. I have answered all his/her questions and he/she provided the affirmative agreement (i.e. assent) to participate in this research.

Investigator's Signature: _____

Date: _____

BOX 137, 525 WEST 120TH STREET, NEW YORK, NY 10027-6696 • (212) 678-3480 • LFEatTC@columbia.edu • www.tc.edu/life



TEACHERS COLLEGE
COLUMBIA UNIVERSITY

ASSENT FORM FOR STUDENTS (Control)

Principal Investigators: *Isobel Contento and Pamela Koch*

Research Title: ***Creature 101: An Educational Computer Game for Healthy Eating and Active Living***

I _____ (child's name) agree to participate in the study entitled: ***Creature 101: An Educational Computer Game for Healthy Eating and Active Living***. The purpose and nature of the study has been fully explained to me by Pamela Koch. I understand what is being asked of me, and should I have any questions, I know that I can contact Pamela or one of her staff at any time. I also understand that I can to quit the study any time I want to.

Name of Participant: _____

Signature of Participant: _____

Witness: _____

Date: _____

Investigator's Verification of Explanation

I certify that I have carefully explained the purpose and nature of this research to _____ (participant's name) in age-appropriate language. He/She has had the opportunity to discuss it with me in detail. I have answered all his/her questions and he/she provided the affirmative agreement (i.e. assent) to participate in this research.

Investigator's Signature: _____

Date: _____

BOX 137, 525 WEST 120TH STREET, NEW YORK, NY 10027-6696 • (212) 678-3480 • LIFeATC@columbia.edu • www.tc.edu/life

TEACHERS COLLEGE, COLUMBIA UNIVERSITY	
INSTITUTIONAL REVIEW BOARD	
Protocol #	09-134CR2
Consent form #	3/1/2012
IRB Signature	SH/MB

APPENDIX-B

Eat-n-Play: What You Do

1. Student ID:**Section-A****2. How often do you drink regular soda?****[DON'T count diet or 0 calorie sodas]**

- ☐ more than 2 times per day
- ☐ about once per day
- ☐ about 5-6 times per week
- ☐ about 3-4 times per week
- ☐ about 1-2 times per week
- ☐ never drink this



3. When you drink regular soda, how much do you usually drink each time?

- ☐ more than 20 ounces
- ☐ about 20 ounces
- ☐ about 12 ounces
- ☐ less than 12 ounces
- ☐ never drink this



4. How often do you drink diet soda?

- ☐ more than 2 times per day
- ☐ about once per day
- ☐ about 5-6 times per week
- ☐ about 3-4 times per week
- ☐ about 1-2 times per week
- ☐ never drink this



12 ounces



20 ounces

5. When you drink diet soda, how much do you usually drink each time?

- ☐ more than 20 ounces
- ☐ about 20 ounces
- ☐ about 12 ounces
- ☐ less than 12 ounces
- ☐ never drink this



6. How often do you drink fruit drinks or flavored sweetened teas?

- ☐ more than 2 times per day
- ☐ about once per day
- ☐ about 5-6 times per week
- ☐ about 3-4 times per week
- ☐ about 1-2 times per week
- ☐ never drink this



8 ounces



12 ounces



20 ounces

7. When you drink fruit drinks or sweetened teas, how much do you usually drink each time?

- ☐ more than 20 ounces
- ☐ about 20 ounces
- ☐ about 12 ounces
- ☐ about 8 ounces
- ☐ never drink this



8. How often do you drink sports drinks?

- ☐ more than 2 times per day
- ☐ about once per day
- ☐ about 5-6 times per week
- ☐ about 3-4 times per week
- ☐ about 1-2 times per week
- ☐ never drink this



20 ounces

9. When you drink sports drinks, how much do you usually drink each time?

- ☐ more than 20 ounces
- ☐ about 20 ounces
- ☐ less than 20 ounces
- ☐ never drink this



10. How often do you drink flavored waters?

- ☐ more than 2 times per day
- ☐ about once per day
- ☐ about 5-6 times per week
- ☐ about 3-4 times per week
- ☐ about 1-2 times per week
- ☐ never drink this



11. When you drink flavored waters, how much do you usually drink each time?

- ☐ more than 20 ounces
- ☐ about 20 ounces
- ☐ less than 20 ounces
- ☐ never drink this



12. How often do you drink seltzer water (carbonated water that does not contain sugar)?

- ☐ more than 2 times per day
- ☐ about once per day
- ☐ about 5-6 times per week
- ☐ about 3-4 times per week
- ☐ about 1-2 times per week
- ☐ never drink this



12 ounces



20 ounces

13. When you drink seltzer water, how much do you usually drink each time?

- ☐ more than 20 ounces
- ☐ about 20 ounces
- ☐ about 12 ounces
- ☐ less than 12 ounces
- ☐ never drink this

14. When you drink water, what source do you normally drink?

- ☐ Tap water from a sink or water fountain
- ☐ Bottled water (plain with no flavoring or sweetener)
- ☐ Both tap water and bottled water



15. How often do you drink bottled water?

- ☐ more than 2 times per day
- ☐ about once per day
- ☐ about 5-6 times per week
- ☐ about 3-4 times per week
- ☐ about 1-2 times per week
- ☐ never drink this



16. When you drink bottled water, how much do you usually drink each time?

- ☐ more than 20 ounces
- ☐ about 20 ounces
- ☐ about 16 ounces(1/2 liter)
- ☐ about 8 ounces
- ☐ less than 8 ounces
- ☐ never drink this

17. How often do you drink tap water (water from a sink or water fountain)?

- ☐ more than 2 times per day
- ☐ about once per day
- ☐ about 5-6 times per week
- ☐ about 3-4 times per week
- ☐ about 1-2 times per week
- ☐ never drink this

**18. When you drink tap water, how much do you usually drink each time?**

- ☐ more than 16 ounces
- ☐ about 16 ounces
- ☐ about 12 ounces
- ☐ about 8 ounces
- ☐ less than 8 ounces
- ☐ never drink this



19. How often do you carry a refillable water bottle with you?

- ☐ about everyday
- ☐ few times a week
- ☐ once a week
- ☐ never carry water bottles

Section-B



20. How often do you eat regular potato chips, tortilla chips and corn chips and other salty snacks?

- ☐ more than 2 times per day
- ☐ about once per day
- ☐ about 5-6 times per week
- ☐ about 3-4 times per week
- ☐ about 1-2 times per week
- ☐ never eat this



21. When you eat regular chips or salty snacks, how much do you eat each time?

- ☐ About 40 chips (1 large bag)
- ☐ About 25 chips (1 medium bag)
- ☐ About 12 chips (1 small bag)
- ☐ Never eat this



22. How often do you eat low fat or baked chips or pretzels?

- ☐ more than 2 times per day
- ☐ about once per day
- ☐ about 5-8 times per week
- ☐ about 3-4 times per week
- ☐ about 1-2 times per week
- ☐ never eat this



23. When you eat low fat or baked chips or pretzels, how much do you eat each time?

- ☐ About 40 (large)
- ☐ About 25 (medium)
- ☐ About 12 (small)
- ☐ Never eat this



24. How often do you eat chocolate candies?

- ☐ more than 2 times per day
- ☐ about once per day
- ☐ about 5-8 times per week
- ☐ about 3-4 times per week
- ☐ about 1-2 times per week
- ☐ never eat this



25. When you eat chocolate candies, what size do you usually eat each time?

- ☐ large
- ☐ medium
- ☐ small
- ☐ never eat this



26. How often do you eat sugary candies?

- ☐ more than 2 times per day
- ☐ about once per day
- ☐ about 5-6 times per week
- ☐ about 3-4 times per week
- ☐ about 1-2 times per week
- ☐ never eat this



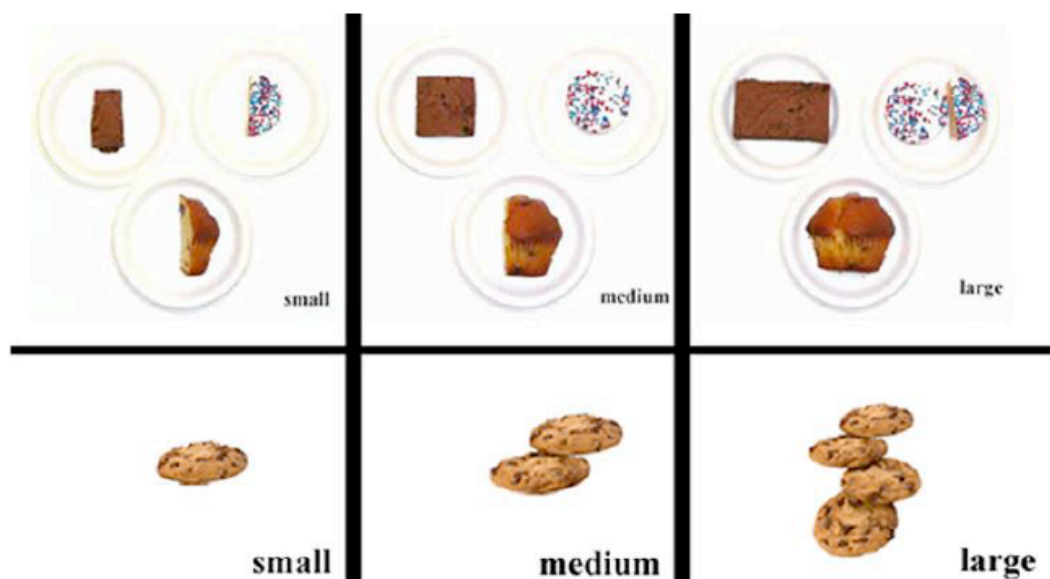
27. When you eat sugary candies, what size do you usually eat each time?

- ☐ large
- ☐ medium
- ☐ small
- ☐ never eat this



28. How often do you eat brownies, muffins, cakes and cookies?

- ☐ more than 2 times per day
- ☐ about once per day
- ☐ about 5-6 times per week
- ☐ about 3-4 times per week
- ☐ about 1-2 times per week
- ☐ never eat this



29. When you eat brownies, muffins, cakes and cookies, what size do you usually eat each time?

- ☐ large
- ☐ medium
- ☐ small
- ☐ never eat this



30. How often do you eat vegetables? (Fresh/frozen/canned. Do not count fried potatoes or French fries)

- ☐ more than 2 times per day
- ☐ about once per day
- ☐ about 5-6 times per week
- ☐ about 3-4 times per week
- ☐ about 1-2 times per week
- ☐ never eat this



31. When you eat vegetables, how much do you usually eat each time?

- ☐ more than 1 cup
- ☐ about 1 cup
- ☐ about $\frac{1}{2}$ cup
- ☐ less than $\frac{1}{2}$ cup
- ☐ never eat vegetables



32. How often do you eat fruits? (Fresh/frozen/canned/dried. Do not count juices)

- ☐ more than 2 times per day
- ☐ about once per day
- ☐ about 5-6 times per week
- ☐ about 3-4 times per week
- ☐ about 1-2 times per week
- ☐ never eat this



33. When you eat fruits, how much do you usually eat each time?

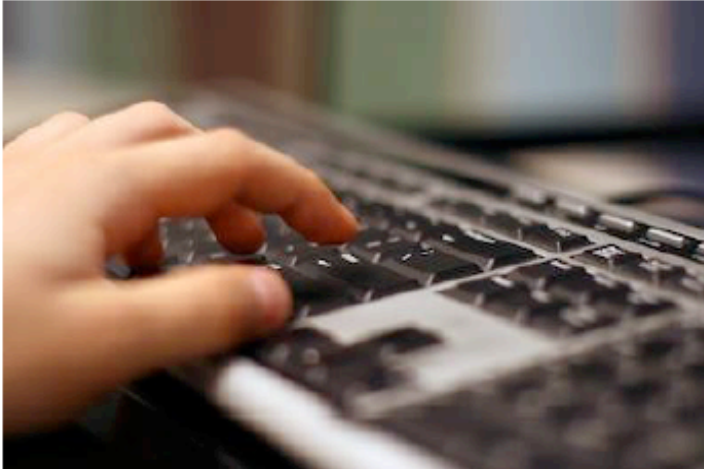
- ☐ more than 1 cup
- ☐ about 1 cup
- ☐ about $\frac{1}{2}$ cup
- ☐ less than $\frac{1}{2}$ cup
- ☐ never eat fruits

Section-C**34. How often do you sit and watch TV?**

- ☐ more than 2 times per day
- ☐ about once per day
- ☐ about 5-6 times per week
- ☐ about 3-4 times per week
- ☐ about 1-2 times per week
- ☐ never watch TV

35. When you sit and watch TV, for how many hours do you usually watch it each time?

- ☐ more than 4 hours
- ☐ between 3-4 hours
- ☐ between 2-3 hours
- ☐ between 1-2 hours
- ☐ less than 1 hour
- ☐ never watch TV



36. How often do you sit and play video or computer games (do not count active Wii)?

- ☐ more than 2 times per day
- ☐ about once per day
- ☐ about 5-6 times per week
- ☐ about 3-4 times per week
- ☐ about 1-2 times per week
- ☐ never play video or computer games

37. When you sit and play video or computer games (do not count Wii), for how many hours do you usually play each time?

- ☐ more than 4 hours
- ☐ between 3-4 hours
- ☐ between 2-3 hours
- ☐ between 1-2 hours
- ☐ less than 1 hour
- ☐ never play video or computer games



38. How often do you do light activities for exercises (such as stretching, walking, climbing down the stairs etc)?

- ☐ more than 2 times per day
- ☐ about once per day
- ☐ about 5-6 times per week
- ☐ about 3-4 times per week
- ☐ about 1-2 times per week
- ☐ never do these activities

39. When you do light activities for exercises, for how many minutes do you usually do them each time?

- ☐ more than 60 minutes (1 hour)
- ☐ between 46-60 minutes
- ☐ between 31-45 minutes
- ☐ between 16-30 minutes
- ☐ between 0-15 minutes
- ☐ never do these activities

Moderate Activity**40. How often do you do moderate activities (dancing, skateboarding, ice-hockey etc)?**

- ☐ more than 2 times per day
- ☐ about once per day
- ☐ about 5-6 times per week
- ☐ about 3-4 times per week
- ☐ about 1-2 times per week
- ☐ never do these activities

41. When you do moderate activities, for how many minutes do you usually do them each time?

- ☐ more than 60 minutes (1 hour)
- ☐ between 46-60 minutes
- ☐ between 31-45 minutes
- ☐ between 16-30 minutes
- ☐ between 0-15 minutes
- ☐ never do these activities

Intense activity

42. How often do you do intense activities (such as soccer, running, karate etc)?

- ☐ more than 2 times per day
- ☐ about once per day
- ☐ about 5-6 times per week
- ☐ about 3-4 times per week
- ☐ about 1-2 times per week
- ☐ never do these activities

43. When you do intense activities, for how many minutes do you usually do them each time?

- ☐ more than 60 minutes (1 hour)
- ☐ between 46-60 minutes
- ☐ between 31-45 minutes
- ☐ between 16-30 minutes
- ☐ between 0-15 minutes
- ☐ never do these activities

About Yourself

44. How old are you?

- ☐ 10 years or younger
- ☐ 11 years
- ☐ 12 years
- ☐ 13 years
- ☐ more than 13 years

45. What is your gender?

- ☐ Male
- ☐ Female

46. Are you Hispanic or Latino?

- ☐ Yes
- ☐ No

47. What is your race?

- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African-American
- ☐ White
- ☐ Native Hawaiian or other Pacific Islander
- ☐ Others

APPENDIX-C

Eat-n-Play: What You Think

1.**1. Student ID:****2.**

1. Many foods and drinks contain sugar in them. What is the recommended maximum amount of sugar you may have in a day?

- ☐ 7 teaspoons
- ☐ 12 teaspoons
- ☐ 17 teaspoons
- ☐ 22 teaspoons

2. Which has more sugar: a bottle of regular soda OR a same sized bottle of sports drink?

- ☐ A bottle of regular soda
- ☐ A bottle of regular sports drink
- ☐ both have same amounts of sugar

3. Which has more sugar: a bottle of regular soda OR a same sized bottle of regular iced tea?

- ☐ a bottle of regular soda
- ☐ a bottle of regular iced tea
- ☐ both have same amounts of sugar

3.

1. How many glasses of water is it recommended to drink in a day?

- ☐ 4 glasses
- ☐ 6 glasses
- ☐ 8 glasses
- ☐ 10 glasses

2. How many peanut butter cups can you eat so that you don't exceed the recommended number of packaged snacks in a day?

- ☐ 1 peanut butter cup
☐ 2 peanut butter cups
☐ 3 peanut butter cups

3. The recommendation for eating fruit and vegetables for children of your age is:

- ☐ about 2 cups (one cup is about the size of your fist) a day
☐ about 3 cups a day
☐ about 4 cups a day
☐ about 5 cups a day

4.

1. Anne ate the following one day:

1-small apple at breakfast

1/2-cup of lettuce at lunch

1/2-cup of baby carrots as a snack

1-cup of cooked green beans at dinner

Did Anne eat the recommended minimum amount of fruits and vegetables that day?

- ☐ She ate less than the recommended minimum
☐ She ate the recommended minimum
☐ She ate more than the recommended minimum

2. Peter ate the following one day:

1 medium sized banana at breakfast

2 cups of salad at lunch

1 big apple at dinner

Did Peter eat the recommended minimum amount of fruits and vegetables that day?

- ☐ He ate less than recommended minimum
☐ He ate the recommended minimum
☐ He ate more than the recommended minimum

5.**1. 1 small apple is about how many cups of fruit?**

- ☐ 0.5 cup
- ☐ 1 cup
- ☐ 1.5 cups
- ☐ 2 cups

2. How many hours (at most) is it recommended that you can you watch TV or play video games in a day?

- ☐ 1 hour
- ☐ 2 hours
- ☐ 3 hours
- ☐ 4 hours

3. How much time is it recommended for children to be physically active each day?

- ☐ 30 minutes
- ☐ 45 minutes
- ☐ 60 minutes
- ☐ 90 minutes

6.

1. Think about you and your friends. Choose the best answer for you for each question.

When I am with my friends we:

	never or almost never	sometimes	often	always or almost always
eat fruits and vegetables.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
eat candy and chips.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
drink soda, fruit punch, or any other sweetened drink.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
drink water.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
mostly watch TV or play video games together	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
mostly play outdoors	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

7.

Think about drinking sweetened beverages (sweetened drinks) such as sodas, fruit punches and sweetened iced teas.

Then tell us what you think about the following statements:

1. I believe that if I drink lots of sweetened drinks I will:

	strongly disagree	disagree	agree	strongly agree
get more calories than my body needs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
stay hydrated in a good way	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
feel sluggish (not able to do activities such as play sports or dance)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
get too heavy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

8.

1. I am sure I can *limit* my intake of sweetened drinks to ____ in a day

- ☐ 1/2 can or less (8 ounces or less)
- ☐ 1 can (12 ounces)
- ☐ 1 small bottle (20 ounce)
- ☐ 1 large bottle (1 liter)
- ☐ I am not sure if I can limit my intake of sweetened drinks

9.

1. I am sure I can avoid drinking sweetened drinks:

	not sure	a little sure	somewhat sure	very sure
after-school	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
on weekends even if I didn't drink them throughout the week	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
when I am at a party	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
by replacing a high sugar drink with one that has low sugar	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

10.

Think about drinking water.

Then tell us what you think about the following statements:

1. I believe by drinking water, I will:

	strongly disagree	disagree	agree	strongly agree
get more calories than my body needs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
reduce my chances of getting sick	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
be hydrated in a good way	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
feel sluggish (not be able to do activities such as play sports or dance)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

11.

1. I am sure I can drink at least _____ water a day

- ☐ a few sips
☐ two glasses
☐ five glasses
☐ eight glasses
☐ I am not sure if I can drink water everyday

12.

1. I am sure I can drink water:

	not sure	a little sure	somewhat sure	very sure
instead of sweetened drinks when I am thirsty	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
instead of sweetened drinks when I am at a party	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
even if my friends are drinking soda	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
at breakfast	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
at lunch	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
at dinner	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

13.

Think about eating **packaged snacks** (snacks that come in small packages or bags such as chocolates, candies, chips, salty snacks, cupcakes, brownies, muffins and other baked goods). Then tell us what you think about the following statements:

1. I believe that if I eat lots of packaged snacks I will:

	strongly disagree	disagree	agree	strongly agree
get more energy than my body needs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
reduce my chances of getting sick	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
get too heavy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
feel sluggish (not be able to do activities such as play sports or dance)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

14.

1. I am sure I can *limit* my intake of packaged snack to _____ in a day.

- ☐ one
☐ two
☐ three
☐ four
☐ I am not sure if I can limit my intake of packaged snacks

15.

1. I am sure I can *avoid* eating packaged snacks:

	not sure	a little sure	somewhat sure	very sure
at lunch at school	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
after-school	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
on weekends even if I didn't eat them throughout the week	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
when I am at a party	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
by replacing with a fruit or a vegetable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

16.

Think about eating fruit and vegetables (do not count **French Fries**). Then tell us what you think about the following statements:

1. I believe by eating fruit and vegetables I will:

	strongly disagree	disagree	agree	strongly agree
reduce my chances of getting sick	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
become too heavy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
feel satisfied	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
help my body function better	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

17.

1. I am sure I can eat at *least* _____ of fruit everyday.

- ☐ 1.0 cup
☐ 1.5 cups
☐ 2.0 cups
☐ 2.5 cups
☐ I am not sure if I can eat any fruit

18.

1. I am sure I can eat at least _____ of vegetables everyday.

- ☐ 1.0 cup
- ☐ 1.5 cups
- ☐ 2.0 cups
- ☐ 2.5 cups
- ☐ I am not sure if I can eat any vegetables

19.

1. I am sure I can eat fruit and/or vegetables regularly at:

	not sure	a little sure	somewhat sure	very sure
breakfast	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
lunch at school	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
snack	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
dinner	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

20.

Sedentary activities are ones where you mostly sit such as watching TV, playing computer or video games.

Then tell us what you think about the following statements.

1. I believe if I do many sedentary activities I will:

	strongly disagree	disagree	agree	strongly agree
reduce my chances of getting sick	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
get too heavy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
feel sluggish	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
have less time to play sports or dance	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

21.

1. I am sure I can *limit* watching TV and playing video games to less than _____ per day:

- ☐ 1 hour
- ☐ 2 hours
- ☐ 3 hours
- ☐ 4 hours
- ☐ I am not sure if I can limit these activities

22.

1. I am sure I can *avoid*:

	not sure at all	a little sure	somewhat sure	very sure
watching TV even if your family is watching it	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
playing video games even if your friends play them	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
doing sedentary (sitting) activities if you are tired	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
doing sedentary (sitting) activities if you are upset	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

23.

Physical activities are activities that get your body moving such as walking, running, stretching, playing soccer, baseball, basketball.

Then tell us what you think about the following statements:

1. I believe if I do physically activities regularly I will:

	strongly disagree	disagree	agree	strongly agree
be in energy balance	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
reduce my chances of getting sick	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
become too heavy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
be sluggish	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

24.

1. I am sure I can be physically active for *at least* _____ hours per day.

- ☐ 1/2 hour
☐ 1 hour
☐ 1.5 hours
☐ 2.0 hours
☐ I am not sure if I can be physically active

25.

1. I am sure I can be physically active:

	not sure	a little sure	somewhat sure	very sure
by mostly using stairs instead of elevators	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
by playing outside with my friends on weekends	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
even if I am tired	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
even if I am upset	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

26.

1. Please tell us how true each statement is for you.

The reason I would eat healthy is because:

	not true at all	a little true	somewhat true	mostly true	very true
it fits in with what I want to do in life	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I personally believe it is the best thing for my life	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I really don't think about it	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
others would be upset with me if I did not	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
it is easier to do what I am told than think about it	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
it is an important choice I really want to make	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would feel bad about myself if I did not eat healthy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I want others to see I can do it	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I don't really know why	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

27.

1. Please indicate how much each statement is true for you.

	not at all true	a little true	somewhat true	mostly true	very true
I feel confident in my ability to eat healthy regularly	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I now feel capable of eating healthy regularly	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am able to meet the challenge of eating healthy regularly	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

28.

1. Please tell us how much each statement is true for you.

The reason I would be physically active is because:

	not true at all	a little true	somewhat true	mostly true	very true
it fits in with what I want to do in life	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I personally believe it is the best thing for my life	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I really don't think about it	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
others would be upset with me if I did not	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
it is easier to do what I am told than think about it	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
it is an important choice I really want to make	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would feel bad about myself if I am not active	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I want others to see I can do it	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I don't really know why	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

29.

1. Please tell us how much each statement is true for you:

	not at all true	a little true	somewhat true	mostly true	very true
I now feel capable of exercising regularly	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am able to meet the challenge of being physically active regularly	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am able to be physically active over the long-term	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

APPENDIX-D

Game Activities

Help save the creatures!: info-introduction

Prereqs:

On complete say:

On activate say:

Type: comic

Activity URL: mod/shai_activity/games/info-introduction/info-introduction.php

Illustration URL: mod/shai_activity/graphics/buttons/info-introduction.jpg



Notebook entry: Wow, Murphy is really amazing! His explorer robot B4U is so cool. Too bad Murphy's idea to bring junk food into Tween didn't work out so well. I hope I can help him.

Group rank: 0

Miscellaneous tags: noskip

Next exercise in sequence: avatar-selection

Resources:

Pick your avatar: avatar-selection

Prereqs:

info-introduction

On complete say:

On activate say:

Type: settings

Activity URL: <mod/avatar/choose.php>

Illustration URL: mod/shai_activity/graphics/buttons/avatar-selection.jpg



Notebook entry:

Group rank: 1

Miscellaneous tags: noskip

Next exercise in sequence: adopt-creature

Resources:

Adopt a creature: adopt-creature

Prereqs:

avatar-selection

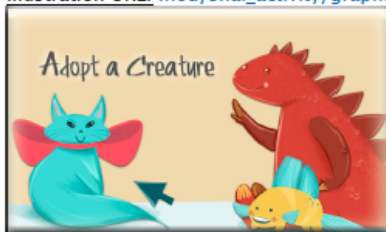
On complete say:

On activate say:

Type: settings

Activity URL: mod/shai_creature/pick.php

Illustration URL: mod/shai_activity/graphics/buttons/adopt-creature.jpg



Notebook entry: I adopted a creature from Tween today. It's sooo cool. I guess it would be even cooler if it wasn't sick. But that'll change. I just gotta figure out what made my creature and all the other creatures sick.

Group rank: 2

Miscellaneous tags: noskip

Next exercise in sequence: quiz-novice

Resources:

resource-creatures

First quiz: quiz-novice

Prereqs:

adopt-creature

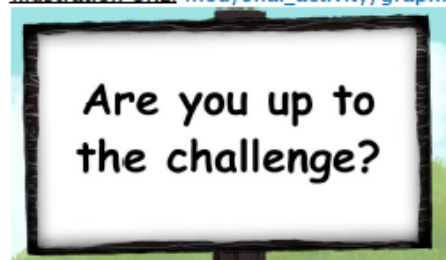
On complete say:

On activate say:

Type: quiz

Activity URL: mod/shai_quiz/take.php

Illustration URL: mod/shai_activity/graphics/buttons/quiz.jpg



Notebook entry: I passed my first quiz today.

Group rank: 3

Miscellaneous tags: noskip

Next exercise in sequence: badge-novice

Resources:

Novice badge award: badge-novice

Prereqs:

quiz-novice

On complete say:

On activate say:

Type: badge

Activity URL: mod/shai_activity/badge/award.php

Illustration URL:

Notebook entry:

Group rank: 4

Miscellaneous tags: jump, norepeat

Next exercise in sequence: murphy-greeting

Resources:

Intro to Creature101: Do you know why the creatures look so sickly?: murphy-greeting

Prereqs:

badge-novice

On complete say:

On activate say:

Type: dialogue

Activity URL: <mod/os/index.php>

Illustration URL: mod/shai_activity/graphics/buttons/murphy-greeting-v2.jpg



Notebook entry:

The coolest thing happened. I met this kid named Murphy. He seems pretty cool and funny. He told me this crazy unbelievable story about another world. So, Murphy's an inventor and he created some sort of wormhole to this world between worlds; he calls it Tween. I didn't believe him. Until he transported us there! It looks a lot like our world. Tween has these really colorful creatures (well they used to be really colorful) that are like nothing I have ever seen before. I couldn't believe it! Then if that wasn't crazy enough, he tells me these creatures are sick now because they have been eating the foods I eat and playing videogames and watching loads of TV like I do all the time. How could those things make you sick?!? I am fine. Then again I have been feeling a little tired lately. I wonder what's in the food that's making them sick? Will it make me sick? And what about playing videogames and watching TV all the time? I told Murphy I would help save the creatures. Can I do it? I sure hope I can. I need to go to my room at the Tween arms to find the Caretaker Manual. It's a must-read if I want to become a Creature Caretaker and save the creatures.

Group rank: 5

Miscellaneous tags: noskip, norepeat

Next exercise in sequence: info-creature-caretaking

Resources:

Creature Care Manual: info-creature-caretaking

Prereqs:

murphy-greeting

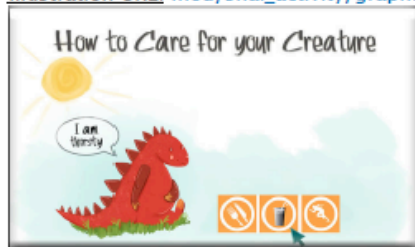
On complete say:

On activate say:

Type: comic

Activity URL: mod/shai_activity/games/info-creature-caretaking/info-creature-caretaking.php

Illustration URL: mod/shai_activity/graphics/buttons/info-creature-caretaking.jpg



Notebook entry:

I learned how to take care of my creature today. Those are demanding little critters! Gotta watch for those creature indicators. Need to make sure they don't bounce too often. My creature is always asking for soda or cookies or to watch TV or play games or something. Crazy! How is it possible that my creature still wants to do all the things and eat all the foods that made it sick to begin with? Taking care of this critter is gonna be harder than I thought.

Second quiz: quiz-ccm

Prereqs:

info-creature-caretaking

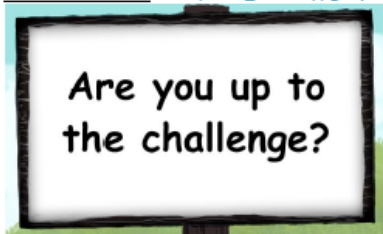
On complete say:

On activate say:

Type: quiz

Activity URL: mod/shai_quiz/take.php

Illustration URL: mod/shai_activity/graphics/buttons/quiz.jpg



Notebook entry: I passed the quiz on the Creature Care Manual. I can find the manual in the Resources tab if I want to look something up.

Group rank: 7

Miscellaneous tags: noskip

Next exercise in sequence: murphy-diet-intro

Resources:

Notebook entry: I passed the quiz on the Creature Care Manual. I can find the manual in the Resources tab if I want to look something up.

Group rank: 7

Miscellaneous tags: noskip

Next exercise in sequence: murphy-diet-intro

Resources:

Go talk to Murphy: Something isn't right with the creatures: murphy-diet-intro

Prereqs:

quiz-ccm

On complete say:

On activate say:

Type: dialogue

Activity URL: <mod/os/index.php>

Illustration URL: mod/shai_activity/graphics/buttons/murphy-diet-intro.jpg



Notebook entry:

Murphy introduced me to Dr. Rodrigo, famous for his wacky experiments. I wonder what he has going on.

It's been a very busy day!

Group rank: 8

Miscellaneous tags: noskip, norepeat

Next exercise in sequence: rodrigo-flyer

Resources:

Science to the rescue: Go see Dr. Rodrigo's wacky experiments: rodrigo-flyer

Prereqs:

murphy-diet-intro

On complete say:

On activate say:

Type: dialogue

Activity URL: <mod/os/index.php>

Illustration URL: mod/shai_activity/graphics/buttons/rodrigo-flyer.jpg



Notebook entry:

Dr. Rodrigo has quite an experiment going on. He told me we are born to like sweet things. I knew that without him telling me!

Group rank: 9

Miscellaneous tags: noskip, norepeat

Next exercise in sequence: info-understanding-taste

Resources:

Sugary foods: Why we like sweets: info-understanding-taste

Prereqs:

rodrigo-flyer

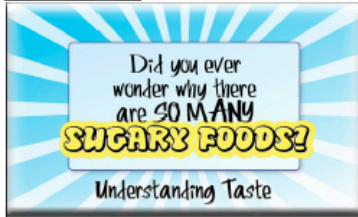
On complete say:

On activate say:

Type: comic

Activity URL: mod/shai_activity/games/info-understanding-taste/info-understanding-taste.php

Illustration URL: mod/shai_activity/graphics/buttons/info-understanding-taste.jpg



Notebook entry:

Turns out the creature's physiology is similar to ours. That means what makes the creatures sick can also make humans sick. And they like what we like and dislike what we dislike. So, I think I figured out why my creature wants to eat the things that made him sick. It's the same reason I like to eat these foods too! It all starts when we are born liking sweet things like cupcakes and candy (Duh!) and not things that are bitter like olives or sour like lemons (Yuck!). That explains why the creatures still want to eat all that candy even though it is making them sick. And it explains why I like candy and soda so much too.

Group rank: 10

Miscellaneous tags: noskip

Next exercise in sequence: murphy-sweets

Resources:

Talk to Murphy about too much sugar: murphy-sweets

Prereqs:

info-understanding-taste

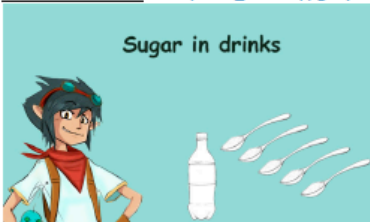
On complete say:

On activate say:

Type: dialogue

Activity URL: <mod/os/index.php>

Illustration URL: mod/shai_activity/graphics/buttons/murphy-sweets.jpg



Notebook entry:

Murphy made a mistake bringing all those snacks from Earth to Tween, but what else can you do if you are hungry? I probably would have brought the same stuff. It just tastes sooo good!

Group rank: 11

Miscellaneous tags: noskip, norepeat

Next exercise in sequence: game-sugar-rush

Resources:

resource-sugar

Sugar rush game: game-sugar-rush

Prereqs:

murphy-sweets

On complete say:

On activate say:

Minimum score:250

Type: game

Activity URL: mod/shai_activity/games/game-sugar-rush/game-sugar-rush.php

Illustration URL: mod/shai_activity/graphics/buttons/game-sugar-rush.jpg



Notebook entry:

Learned all about how much sugar is in some of my favorite drinks today. I was super surprised to find out just how much sugar is in one bottle of soda: 17 teaspoons! Whoa! I drink those almost everyday. I would never pour that much sugar into a cup and drink it, but that's kind of what I am doing when I drink a bottle of soda, huh? I guess I never thought of it that way. All of this sugar has to be part of the reason the creatures are getting sick.

8 oz soda = 5 -7 teaspoons
 12 oz soda = 9 -11 teaspoons
 20 oz sports drink = 9 - 11 teaspoons
 32 oz sports drink = 14 - 17 teaspoons
 20 oz flavored water = 5 -7 teaspoons
 16 oz energy drink = 9 - 11 teaspoons
 Water = 0 teaspoons

Water doesn't have any sugar. My creature and I are going to be drinking fewer sweetened drinks and a lot more water!

Group rank: 12

Miscellaneous tags:

Next exercise in sequence: murphy-blood-sugar

Resources:

Talk to Murphy about sugar being in your blood: mурphy-blood-sugar

Prereqs:

game-sugar-rush

On complete say:

On activate say:

Type: dialogue

Activity URL: <mod/os/index.php>

Illustration URL: mod/shai_activity/graphics/buttons/murphy-blood-sugar.jpg



Notebook entry:

Group rank: 13

Miscellaneous tags: noskip, norepeat

Next exercise in sequence: badge-junior

Resources:

Junior badge award: badge-junior

Prereqs:

mурphy-blood-sugar

On complete say:

On activate say:

Type: badge

Activity URL: mod/shai_activity/badge/award.php

Illustration URL:

Notebook entry:

Group rank: 14

Miscellaneous tags: jump, norepeat

Creature caretaker training: See Murphy: mурphy-likert-intro

Prereqs:

badge-junior

On complete say:

On activate say:

Type: dialogue

Activity URL: <mod/os/index.php>

Illustration URL: mod/shai_activity/graphics/buttons/murphy-likert-intro.jpg



Notebook entry: 0

Group rank: 15

Miscellaneous tags: noskip, norepeat

Next exercise in sequence: rodrigo-likert-start

Resources:

Dr. Rodrigo needs your help with his experiment!: rodrigo-likert-start

Prereqs:

murphy-likert-intro

On complete say:

On activate say:

Type: dialogue

Activity URL: <mod/os/index.php>

Illustration URL: mod/shai_activity/graphics/buttons/rodrigo-likert-start.jpg



Notebook entry: 0

Group rank: 16

Miscellaneous tags: noskip, norepeat

Next exercise in sequence: survey-ffv

Resources:

How tempting are French Fries to you?: survey-ffv

Prereqs:

rodrigo-likert-start

On complete say:

On activate say:

Type: survey

Activity URL: mod/shai_survey/take.php

Illustration URL: mod/shai_activity/graphics/buttons/survey-ffv.jpg



Notebook entry:

Creature physiology is similar to humans! Can't believe I was so susceptible to the allure of french fries! Dr. Rodrigo is onto something. Creatures like fatty foods and the smell, just like us humans. I guess it's not good to feed them too many fatty snacks then.

Group rank: 17

Miscellaneous tags: noskip

Next exercise in sequence: rodrigo-likert-result

Resources:

Do you know how much fat in food is good for you?: rodrigo-likert-result

Prereqs:

survey-ffv

On complete say:

On activate say:

Type: dialogue

Activity URL: <mod/os/index.php>

Illustration URL: mod/shai_activity/graphics/buttons/rodrigo-likert-result.jpg



Notebook entry:

Note to self: Never finish a big bag of chips by myself again! Baked chips are a good alternative. I'll feed those to my creature from now on. I think it will be acceptable. I became an Apprentice Caretaker! Dr. Rodrigo told me about Dr. Angela, an expert on the food system. Will go introduce myself to her later.

Group rank: 18

Miscellaneous tags: noskip, norepeat

Next exercise in sequence: game-fat

Resources:

resource-fats

Put fat where it belongs!: game-fat

Prereqs:

rodrigo-likert-result

On complete say:

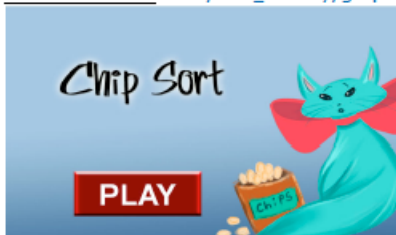
On activate say:

Minimum score:90

Type: game

Activity URL: mod/shai_activity/games/game-fat/game-fat.php

Illustration URL: mod/shai_activity/graphics/buttons/game-fat.jpg



Notebook entry:

Okay, seriously, this is getting even crazier. Today I learned how much fat is in my favorite snacks. Looks like I'm going to have to cut back on the fried chips too. What's next?!? One of my favorites has more than two teaspoons of fat! Imagine scooping out two tea spoons of butter or lard and eating it. Gag! The huge amount of fat in snacks like chips must be another part of the reason the creatures are so sick. These snacks have a lot of fat! Now I know just how much:

0.5 oz Doritos = 1 tsp fat
 1.5 oz Doritos > 2 tsp fat
 1.0 oz Cheez-It = 2 tsp fat
 0.5 oz Sun Chips = 1 tsp fat
 1.0 oz Sun Chips = 2 tsp fat
 1.5 oz Sun Chips > 2 tsp fat
 0.5 oz Lays = 1 tsp fat
 1.0 oz Lays = 2 tsp fat
 1.5 oz Lays > 2 tsp fat
 0.5 oz Baked Lays < 1 tsp fat
 1.0 oz Baked Lays < 1 tsp fat
 1.5 oz Baked Lays < 1 tsp fat
 0.5 Cheetos = 1 tsp fat

Group rank: 19Miscellaneous tags:Next exercise in sequence: info-cloggingResources:**Excess fat: info-clogging**Prereqs:

game-fat

On complete say:On activate say:Type: dialogueActivity URL: <mod/os/index.php>Illustration URL: mod/shai_activity/graphics/buttons/info-clogging.jpgNotebook entry:Group rank: 20Miscellaneous tags: noskip, norepeatNext exercise in sequence: badge-apprenticeResources:

Apprentice badge award: badge-apprentice

Prereqs:

info-clogging

On complete say:

On activate say:

Type: badge

Activity URL: mod/shai_activity/badge/award.php

Illustration URL:

Notebook entry:

Dr. Rodrigo said something today I don't understand. What does he mean by, "How food is produced is part of both the problem and the solution?" Hopefully I'll get to the bottom of that.

Group rank: 21

Miscellaneous tags: jump, norepeat

Next exercise in sequence: murphy-fat-sugar

Resources:

Learn about fat and sugar: murphy-fat-sugar

Prereqs:

badge-apprentice

On complete say:

On activate say:

Type: dialogue

Activity URL: <mod/os/index.php>

Illustration URL: mod/shai_activity/graphics/buttons/murphy-fat-sugar.jpg



Notebook entry:

Group rank: 22

Miscellaneous tags: noskip, norepeat

Next exercise in sequence: game-snack

Resources:

Processed Snacks: The Domino Train Game: game-snack

Prereqs:

murphy-fat-sugar

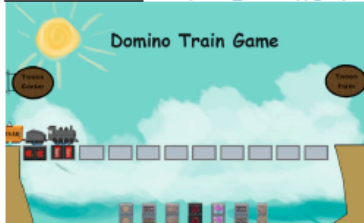
On complete say:

On activate say:

Type: game

Activity URL: mod/shai_activity/games/game-snack/game-snack.php

Illustration URL: mod/shai_activity/graphics/buttons/game-snack.jpg



Notebook entry: 0

Group rank: 23

Miscellaneous tags:

Next exercise in sequence: murphy-chom

Resources:

Essential skills for an Apprentice Caretaker: Ask Murphy about the CHOM!: murphy-chom

Prereqs:

game-snack

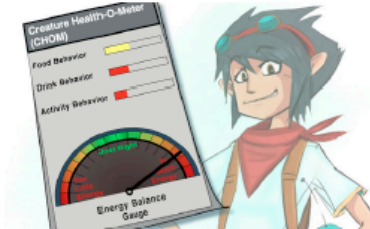
On complete say:

On activate say:

Type: dialogue

Activity URL: <mod/os/index.php>

Illustration URL: mod/shai_activity/graphics/buttons/murphy-chom.jpg



Notebook entry:

Murphy introduced to me the Creature-Health-O-Meter, CHOM.

He told me to go to Dr. Rodrigo to learn about it.

Group rank: 24

Miscellaneous tags: noskip, norepeat

Next exercise in sequence: chom-and-behavior-bars

Resources:

Creature Health-O-Meter: chom-and-behavior-bars

Prereqs:

murphy-chom

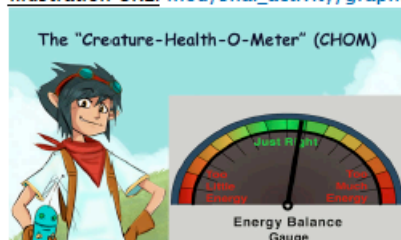
On complete say:

On activate say:

Type: comic

Activity URL: mod/shai_activity/games/info-chom/info-chom.php

Illustration URL: mod/shai_activity/graphics/buttons/chom-and-behavior-bars.jpg



Notebook entry:

I learned about the CHOM, sounds official huh? It stands for Creature-Health-O-Meter. It pretty much keeps track of my creature's energy. When my creature eats something with lots of sugar or fat the energy gauge goes waaaaayyy up, to the right, but when my creature eats fruits or vegetables the meter goes to the right but not as much as when it eats processed foods. A brownie makes the bar smaller and red while broccoli makes it bigger and green. Same concept applies to beverages. Soda makes the bar a lot more red than plain water!

Group rank: 25

Miscellaneous tags: noskip

Next exercise in sequence: quiz-chom

Resources:

Third quiz: quiz-chom

Prereqs:

chom-and-behavior-bars

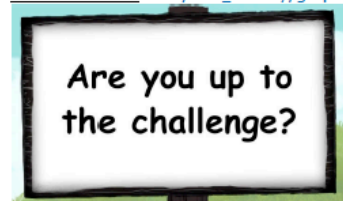
On complete say: If your CHOM is not in the green this is a good time to go to "Jump to My Inventory" to buy some healthful food and activities for your creature!

On activate say:

Type: quiz

Activity URL: mod/shai_quiz/take.php

Illustration URL: mod/shai_activity/graphics/buttons/quiz.jpg



Notebook entry: I passed the quiz on the CHOM.

Group rank: 26

Miscellaneous tags: noskip

Next exercise in sequence: murphy-introduce-claire

Resources:

Talk to Murphy and then visit Claire at the Tween organic farm: murphy-

introduce-claire

Prereqs:

quiz-chom

On complete say:

On activate say:

Type: dialogue

Activity URL: <mod/os/index.php>

Illustration URL: mod/shai_activity/graphics/buttons/murphy-introduce-claire.jpg



Notebook entry:

I visited a farm in Tween today. It was awesome. Nice place! So peaceful there. There was tons of grass and fresh fruit and vegetables. The farmer, Claire, taught me about organic farming. She doesn't use any pesticides! That's good for the environment and the health of humans and creatures.

Group rank: 27

Miscellaneous tags: noskip, norepeat

Next exercise in sequence: claire-intro

Resources:

Join the organic revolution: Discover the benefits of organic farming: claire-intro

Prereqs:

murphy-introduce-claire

On complete say:

On activate say:

Type: dialogue

Activity URL: <mod/os/index.php>

Illustration URL: mod/shai_activity/graphics/buttons/claire-intro.jpg



Notebook entry:

I think now I may know what Dr. Rodrigo means by, "How food is produced is part of both the problem and the solution?" Claire is helping to solve the problems with our food system by producing healthy vegetables using organic methods.

Group rank: 28

Miscellaneous tags: noskip, norepeat

Next exercise in sequence: sally-token-intro

Resources:

Get a job: You got farming to do: sally-token-intro

Prereqs:

claire-intro

On complete say:

On activate say:

Type: dialogue

Activity URL: <mod/os/index.php>

Illustration URL: mod/shai_activity/graphics/buttons/sally-token-intro.jpg



Notebook entry:

Group rank: 29

Miscellaneous tags: noskip, norepeat

Next exercise in sequence: claire-outro

Resources:

Farming life: claire-outro

Prereqs:

sally-token-intro

On complete say:

On activate say:

Type: dialogue

Activity URL: <mod/os/index.php>

Illustration URL: mod/shai_activity/graphics/buttons/claire-outro.jpg



Notebook entry:

Group rank: 30

Miscellaneous tags: noskip, norepeat

Next exercise in sequence: murphy-fruit-vegetables

Resources:

Murphy explains why fruits and vegetables are good for us: murphy-fruit-vegetables

Prereqs:

claire-outro

On complete say:

On activate say:

Type: dialogue

Activity URL: <mod/os/index.php>

Illustration URL: mod/shai_activity/graphics/buttons/murphy-fruit-vegetables.jpg



Notebook entry:

Group rank: 31

Miscellaneous tags: noskip, norepeat

Next exercise in sequence: game-fv-puzzle

Resources:

Fruit and Vegetable Puzzle: game-fv-puzzle

Prereqs:

murphy-fruit-vegetables

On complete say:

On activate say:

Type: game

Activity URL: mod/shai_activity/games/game-fv-puzzle/game-fv-puzzle.php

Illustration URL: mod/shai_activity/graphics/buttons/game-fv-puzzle.jpg



Notebook entry: 0

Group rank: 32

Miscellaneous tags: noskip

Next exercise in sequence: murphy-portion

Resources:

Food intake: murphy-portion

Prereqs:

game-fv-puzzle

On complete say:

On activate say:

Type: dialogue

Activity URL: mod/os/index.php

Illustration URL: mod/shai_activity/graphics/buttons/murphy-portion.jpg



Notebook entry:

Group rank: 33

Miscellaneous tags: noskip, norepeat

Next exercise in sequence: info-portion-size

Resources:

Learn to size up your food: info-portion-size

Prereqs:

murphy-portion

On complete say:

On activate say:

Type: comic

Activity URL: mod/shai_activity/games/info-portion-size/info-portion-size.php

Illustration URL: mod/shai_activity/graphics/buttons/info-portion-size.jpg



Notebook entry:

I learned that food can be measured in terms portions which are made up of weight and volume. I have to judge the portion sizes based on packaging, weight, comparison to other things like my fist, and so on. It's not easy!

Group rank: 34

Miscellaneous tags: noskip

Next exercise in sequence: questionnaire-snacks

Resources:

Fill out a questionnaire about your snack consumption: questionnaire-snacks

Prereqs:

info-portion-size

On complete say:

On activate say:

Type: questionnaire

Activity URL: mod/shai_questionnaire/take.php?activity_ident=snacks

Illustration URL: mod/shai_activity/graphics/buttons/questionnaire-snacks.jpg



Notebook entry: 0

Group rank: 35

Miscellaneous tags: noskip

Next exercise in sequence: questionnaire-beverages

Resources:

Fill out a questionnaire about your beverage consumption: questionnaire-beverages

Prereqs:

questionnaire-snacks

On complete say:

On activate say:

Type: questionnaire

Activity URL: mod/shai_questionnaire/take.php?activity_ident=beverages

Illustration URL: mod/shai_activity/graphics/buttons/questionnaire-beverages.jpg



Notebook entry: 0

Group rank: 36

Miscellaneous tags: noskip

Next exercise in sequence: questionnaire-fruits

Resources:

Fill out a questionnaire about your fruit and vegetable consumption: questionnaire-fruits

Prereqs:

questionnaire-beverages

On complete say:

On activate say:

Type: questionnaire

Activity URL: mod/shai_questionnaire/take.php?activity_ident=fruits

Illustration URL: mod/shai_activity/graphics/buttons/questionnaire-fruits.jpg



Notebook entry: 0

Group rank: 37

Miscellaneous tags: noskip

Next exercise in sequence: questionnaire-water

Resources:

Fill out a questionnaire about your water consumption: questionnaire-water

Prereqs:

questionnaire-fruits

On complete say:

On activate say:

Type: questionnaire

Activity URL: mod/shai_questionnaire/take.php?activity_ident=water

Illustration URL: mod/shai_activity/graphics/buttons/questionnaire-water.jpg



Notebook entry: 0

Group rank: 38

Miscellaneous tags: noskip

Next exercise in sequence: questionnaire-summary

Resources:

Food behavior summary: questionnaire-summary

Prereqs:

questionnaire-water

On complete say:

On activate say:

Type: questionnaire

Activity URL: mod/shai_questionnaire/summary.php

Illustration URL: mod/shai_activity/graphics/buttons/questionnaire-summary.jpg



Notebook entry: 0

Group rank: 39

Miscellaneous tags: noskip

Next exercise in sequence: questionnaire-pa

Resources:

Fill out a questionnaire about your physical activity: questionnaire-pa

Prereqs:

questionnaire-summary

On complete say:

On activate say:

Type: questionnaire

Activity URL: mod/shai_questionnaire/take.php?activity_ident=pa

Illustration URL: mod/shai_activity/graphics/buttons/questionnaire-pa.jpg



Notebook entry: 0

Group rank: 40

Miscellaneous tags: noskip

Next exercise in sequence: questionnaire-summarypa

Resources:

Physical activity summary: questionnaire-summary-pa

Prereqs:

questionnaire-pa

On complete say:

On activate say:

Type: questionnaire

Activity URL: mod/shai_questionnaire/summary_pa.php

Illustration URL: mod/shai_activity/graphics/buttons/questionnaire-summary-pa.jpg



Notebook entry: 0

Group rank: 41

Miscellaneous tags: noskip

Next exercise in sequence: badge-sa

Senior Apprentice badge award: badge-sa

Prereqs:

questionnaire-summary-pa

On complete say:

On activate say:

Type: badge

Activity URL: mod/shai_activity/badge/award.php

Illustration URL:

Notebook entry: 0

Group rank: 42

Miscellaneous tags: jump, norepeat

Next exercise in sequence: murphy-activity

Resources:

Physical activities: murphy-activity

Prereqs:

badge-sa

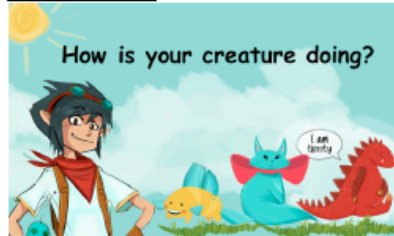
On complete say:

On activate say:

Type: dialogue

Activity URL: <mod/os/index.php>

Illustration URL: mod/shai_activity/graphics/buttons/murphy-activity.jpg



Notebook entry:

Group rank: 43

Miscellaneous tags: noskip, norepeat
 Next exercise in sequence: rodrigo-activity
 Resources:

Creature physical activities: rodrigo-activity

Prereqs:

murphy-activity

On complete say:

On activate say:

Type: dialogue

Activity URL: <mod/os/index.php>

Illustration URL: mod/shai_activity/graphics/buttons/rodrigo-activity.jpg



Notebook entry:

Group rank: 44

Miscellaneous tags: noskip, norepeat

Next exercise in sequence: stage5-food-digestive-system

Resources:

Learn how foods are processed in the digestive system: stage5-food-digestive-system

Prereqs:

rodrigo-activity

On complete say:

On activate say:

Type: game

Activity URL: mod/shai_activity/games/stage5-food-digestive-system/stage5-food-digestive-system.php

Illustration URL: mod/shai_activity/graphics/buttons/kitses.gif



Notebook entry:

Who knew there were so many steps involved in eating and digestion?!? I learned all about how different foods are digested. Digestion starts in the mouth. Once we put in our mouths our teeth break up the food into small parts (except for things like ice cream that melt in our mouth and liquids) and then enzymes in saliva break down the food into even smaller particles. The next stop is the stomach, where digestive juices are mixed in with the food. This is also where any protein particles start to break down. From there, it moves into the first part of the small intestine called the duodenum. Here the food particles continue to be broken down. In the next part of the small intestine, called the ileum, sugar, protein, fat, vitamins and minerals are in small enough particles to be absorbed. All that's left is waste material (mostly fiber) and water. By now it is a nasty brownish color, looks a little like, well.

Anyway, water is absorbed in the colon as the undigested stuff moves toward the rectum. Whatever is left of the food is stored in the rectum. Then it is expelled through the anus. Gross!

Group rank: 45

Miscellaneous tags: noskip

Next exercise in sequence: rodrigo-energy

Resources:

Using the CHOM to help your creature thrive: rodrigo-energy

Prereqs:

stage5-food-digestive-system

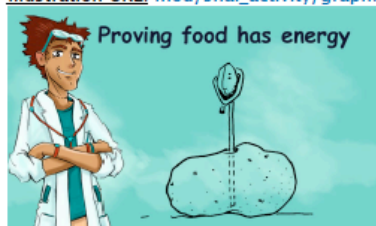
On complete say:

On activate say:

Type: dialogue

Activity URL: <mod/os/index.php>

Illustration URL: mod/shai_activity/graphics/buttons/rodrigo-energy.jpg



Notebook entry:

Activity also affects the CHOM. It takes energy to do activities like walking, biking and even to just keep our bodies working each day. It was interesting to see that as the creature does an activity the Energy Gauge moves in the opposite direction as when it eats something. This is because activities USE energy. These things make the CHOM gauge go to the left because they use up energy. Some activities like biking and playing soccer use a lot of energy while others like playing videogames or watching TV don't use as much energy. The goal is to keep our bodies in energy balance so that how much energy we take in matches how much energy we use each day. That would be the middle green zone on the CHOM. I have to practice using it to keep the gauge always in the green zone. This is not easy!

Group rank: 46

Miscellaneous tags: noskip, norepeat

Next exercise in sequence: rodrigo-calorimetry

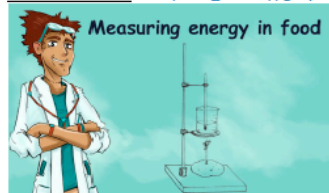
Resources:

resource-bmi

Measuring energy released by food: rodrigo-calorimetry

Prereqs:

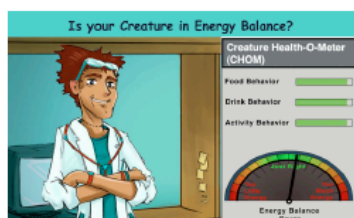
rodrigo-energy

On complete say:On activate say:Type: dialogueActivity URL: <mod/os/index.php>Illustration URL: mod/shai_activity/graphics/buttons/rodrigo-calorimetry.jpgNotebook entry:Group rank: 47Miscellaneous tags: noskip, norepeatNext exercise in sequence: rodrigo-barsResources:

resource-fueling

Behavior bars: rodrigo-barsPrereqs:

rodrigo-calorimetry

On complete say:On activate say:Type: dialogueActivity URL: <mod/os/index.php>Illustration URL: mod/shai_activity/graphics/buttons/rodrigo-bars.jpgNotebook entry:

The Food Behavior Bar is a tough one! You have to balance diet and exercise in order for the bar to stay in a good position. The Drink Behavior Bar is similar to the Food Behavior Bar. When I give my creature a soda or an energy drink or something like that the bar eventually turns red. But if I give my creature water the bar will turn green. Green is good. I better slow down feeding my creature soda. I want to make sure I give my creature plenty of water to keep my creature's drink behavior bar green, but also keep it happy.

The Activity Behavior Bar looks hard to use. I can't let my creature play videogames all day, that's for sure. Just like the other two behavior bars, things that help my creature stay healthy makes the bar turn green. Soccer and Frisbee = green. But, doing too much of the things that can make my creature sick will make the bar turn red. Too many videogames or watching TV = red. Need to mix in some sports.

Wow, training to become a Master Caretaker is no cakewalk!

Group rank: 48Miscellaneous tags: noskip, norepeatNext exercise in sequence: murphy-goalsResources:**Make goals: murphy-goals**Prereqs:

rodrigo-bars

On complete say:

On activate say:

Type: dialogue

Activity URL: <mod/os/index.php>

Illustration URL: mod/shai_activity/graphics/buttons/murphy-goals.jpg



Notebook entry:

Group rank: 49

Miscellaneous tags: noskip, norepeat

Next exercise in sequence: goalsetting-food

Resources:

Set food goals: goalsetting-food

Prereqs:

murphy-goals

On complete say:

On activate say:

Type: settings

Activity URL: mod/shai_goalsetting/goalsetting0.php

Illustration URL: mod/shai_activity/graphics/buttons/goalsetting-food.jpg



Notebook entry: 0

Group rank: 50

Miscellaneous tags: noskip

Next exercise in sequence: goalsetting-pa

Resources:

Set physical activity goals: goalsetting-pa

Prereqs:

goalsetting-food

On complete say: Check your CHOM: if the gauge and bars are not green, give your creature more fruits, vegetables, water, and sports.

On activate say:

Type: settings

Activity URL: mod/shai_goalsetting/gspa0.php

Illustration URL: mod/shai_activity/graphics/buttons/goalsetting-pa.jpg



Notebook entry: 0
Group rank: 51
Miscellaneous tags: noskip
Next exercise in sequence: murphy-food-science
Resources:

Food science: murphy-food-science

Prereqs:
 goalsetting-pa

On complete say:
On activate say:
Type: dialogue
Activity URL: <mod/os/index.php>
Illustration URL: mod/shai_activity/graphics/buttons/murphy-food-science.jpg



Notebook entry:
Group rank: 52
Miscellaneous tags: noskip, norepeat
Next exercise in sequence: angela-intro
Resources:

Dive into the core of the human food system: angela-intro

Prereqs:

On complete say:
On activate say:
Type: dialogue
Activity URL: <mod/os/index.php>
Illustration URL: mod/shai_activity/graphics/buttons/angela-intro.jpg



Notebook entry:
 According to Dr. Angela, the sun is the source of energy for all foods. Any kind of food, even purple funky, starts with something that's grown in the ground, then processed to become what it is in the packaging at the store. Marketing is used for us to hear about the foods available for sale.

Group rank: 53
Miscellaneous tags: noskip, norepeat
Next exercise in sequence: info-food-production
Resources:
 resource-professional

The Human Food System in a nutshell: info-food-production

Prereqs:
 angela-intro

The Human Food System in a nutshell: info-food-production

Prereqs:

angela-intro

On complete say:

On activate say: Check your CHOM: if the gauge and bars are not green, give your creature more fruits, vegetables, water, and sports.

Type: comic

Activity URL: mod/shai_activity/games/info-food-production/info-food-production.php

Illustration URL: mod/shai_activity/graphics/buttons/info-food-production.jpg



Notebook entry:

Who knew you could study the science of food? I guess I never really thought about where my food came from before. I just thought my mom bought it at the supermarket! Turns out, no matter what food I am eating it all started with the sun. First, the sun provides the energy needed for the plant to grow. Once the plant is ready it can go down many paths. Some of the plants are sold as is, like fruits and vegetables. Other plants are processed into ingredients to make other foods, like Purple Funky Candy. I love those commercials. The song always gets stuck in my head. Buy PFC! PFC is fun! PFC is cool! PFC is good! Buy PFC! Anyway, some of the plants are eaten by animals, which is where we get our meat. Some foods are marketed to us through ads on TV, in magazines and newspapers, on the radio, and online. Usually only processed foods are marketed. Come to think of it I have never seen a commercial for broccoli.

Group rank: 54

Miscellaneous tags: noskip

Next exercise in sequence: info-food-advertising

Resources:

resource-protein

Do you really believe what commercials say?: info-food-advertising

Prereqs:

info-food-production

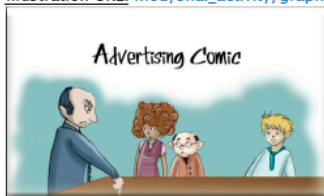
On complete say:

On activate say:

Type: comic

Activity URL: mod/shai_activity/games/info-advertising/info-advertising.php

Illustration URL: mod/shai_activity/graphics/buttons/info-advertising.jpg



Notebook entry:

Kids naturally like sweet foods. Many food companies know this and use it to sell their foods, even if they aren't the healthiest options. Those pretty pictures in commercials seem too fake! For the food companies, it's all about selling a product, but not our health.

Group rank: 55

Miscellaneous tags: noskip

Next exercise in sequence: angela-changes

Resources:

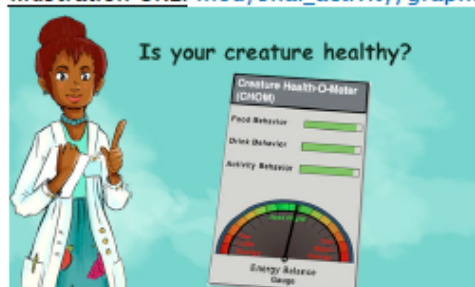
Making changes for ourselves (Part 1): angela-changes

Prereqs:

info-food-advertising

Prereqs:

angela-changes

On complete say:On activate say:Type: dialogueActivity URL: <mod/os/index.php>Illustration URL: mod/shai_activity/graphics/buttons/angela-changes-alt.jpgNotebook entry:

I watched a trailer for a movie, "What's on your plate?" today. I can't wait to see the whole thing! It's a documentary about two girls my age who are trying to figure out where our food comes from. Some of it comes from as far away as Israel! That's far! But some of it comes from local farmers. Even in a big city like New York, there are farmers markets where you can meet the farmers that grow your food. I would love to meet a farmer. Anyway, so in the movie the girls they go to stores and farmers markets. One package of food in a store they went to had an ingredient they couldn't even pronounce! It sure didn't sound like any food I had ever heard of. supercalifragilisticexpialidocious.

After the trailer I searched the internet for more info about the movie. I found this website:
<http://www.whatsonyourplateproject.org/>. It had fun games and more videos from the movie!

Group rank: 57Miscellaneous tags: noskip, norepeatNext exercise in sequence: badge-masterResources:**Master badge award: badge-master**Prereqs:

angela-changes2

On complete say:On activate say:Type: badgeActivity URL: mod/shai_activity/badge/award.phpIllustration URL:

Notebook entry: I'm a master creature caretaker! Yes!!!! I did it. All is well in Tween. The creatures are all healthy and bright again. I learned so much about my world and my body by taking care of Tween. I will do all I can to keep them healthy and teach other humans how they can do the same for themselves. Boy am I hungry after all this hard work. I think I'll go get me an apple!

Group rank: 58Miscellaneous tags: jump, norepeatNext exercise in sequence: angela-congratsResources:

Congratulations from Angela: angela-congrats

Prereqs:

badge-master

On complete say:

On activate say:

Type: dialogue

Activity URL: <mod/os/index.php>

Illustration URL: mod/shai_activity/graphics/buttons/angela-congrats.jpg



Notebook entry:

Group rank: 59

Miscellaneous tags: noskip, norepeat

Next exercise in sequence: murphy-report

Resources:

Congratulations from Murphy: murphy-report

Prereqs:

angela-congrats

On complete say:

On activate say:

Type: dialogue

Activity URL: <mod/os/index.php>

Illustration URL: mod/shai_activity/graphics/buttons/murphy-report.jpg



Notebook entry:

Group rank: 60

Miscellaneous tags: noskip, norepeat

Next exercise in sequence: essay

Resources:

Write about food: essay

Prereqs:

murphy-report

On complete say:

On activate say:

Type: questionnaire

Activity URL: mod/shai_essay/add.php

Illustration URL: mod/shai_activity/graphics/buttons/essay.jpg



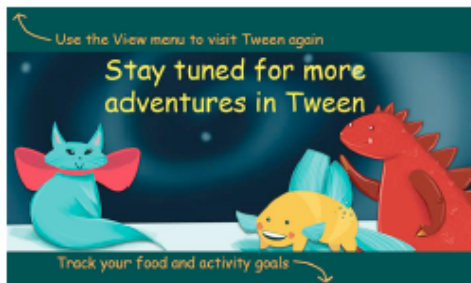
Notebook entry: 0
Group rank: 61
Miscellaneous tags: noskip
Next exercise in sequence: fireworks
Resources:

You're done!: fireworks

Prereqs:
 essay
On complete say:
On activate say:
Type: badge
Activity URL: mod/shai_activity/games/fireworks/fireworks.php
Illustration URL:
Notebook entry: 0
Group rank: 62
Miscellaneous tags: jump, norepeat
Next exercise in sequence: final
Resources:

You're done!: final

Prereqs:
 fireworks
On complete say:
On activate say:
Type: link
Activity URL: <pg/goalsetting/track>
Illustration URL: mod/shai_activity/graphics/buttons/you-are-done.jpg



Notebook entry: 0
Group rank: 63
Miscellaneous tags: noskip
Next exercise in sequence: nothing
Resources: